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EVALUATION OF INSTALLATION
OF
UHF TAIL CAP ANTENNA IN F-86A AND E AIRCRAFT

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JULY 1952

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WRIGHT AIR DEVELOPMENT CENTER

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**EVALUATION OF INSTALLATION
OF
UHF TAIL CAP ANTENNA IN F-86A AND E AIRCRAFT**

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July 1952

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SEO No. S-102-54*

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

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FOREWORD

THE MATERIAL PRESENTED IN THIS REPORT WAS AUTHORIZED BY AIR RESEARCH AND DEVELOPMENT COMMAND TECHNICAL INSTRUCTION NO. 2207-30. WORK WAS INITIATED AS A PROJECT OF WRIGHT AIR DEVELOPMENT CENTER UNDER SERVICE ENGINEERING ORDER S-102-54, ENTITLED, "RETROFIT INSTALLATION OF RADIO SET AN/ARC-27 IN USAF AIRCRAFT". THE PROJECT WAS ADMINISTERED UNDER THE DIRECTION OF COMPONENTS AND SYSTEMS LABORATORY OF WEAPONS COMPONENTS DIVISION, WITH MAJOR WILLIAM F. SANDUSKY ACTING AS PROJECT ENGINEER AND 2ND LT. ROBERT C. LOLLAR ACTING AS ASSISTANT PROJECT ENGINEER. FLIGHT TESTS WERE CONDUCTED AT WRIGHT-PATTERSON AIR FORCE BASE DURING THE PERIOD BETWEEN 20 FEBRUARY 1952 AND 14 MARCH 1952.

INCLUDED AMONG THOSE WHO COOPERATED IN THE TESTS WERE MESSRS. R. T. DOWNEY, C. W. GUELZOW, E. L. BARTON, W. E. LUGINBUHL, ALL MEMBERS OF COMPONENTS AND SYSTEMS LABORATORY, WRIGHT AIR DEVELOPMENT CENTER, AND 1ST LT. W. A. ROSS, FIGHTER FLIGHT TEST SECTION, FLIGHT TEST DIVISION, WRIGHT AIR DEVELOPMENT CENTER.

THIS REPORT IS THE THIRD IN A SERIES ON ULTRA HIGH FREQUENCY ANTENNA FLIGHT TESTS CONDUCTED ON VARIOUS FIGHTER AIRCRAFT. WADC TECHNICAL REPORT NO. 52-70, "EVALUATION OF INSTALLATION OF UHF TAIL CAP ANTENNA IN F-94A AIRCRAFT", AND WADC TECHNICAL REPORT NO. 52-104, "EVALUATION OF INSTALLATION OF UHF TAIL CAP ANTENNA IN F-89 TYPE AIRCRAFT" ARE THE FIRST AND SECOND REPORTS, RESPECTIVELY, OF THE SERIES.

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ABSTRACT

AN ULTRA HIGH FREQUENCY TAIL CAP ANTENNA WHICH WAS FABRICATED AND INSTALLED ON AN F-86A AIRCRAFT BY NORTH AMERICAN AVIATION, INC., WAS SUBJECTED TO FLIGHT TESTS AS OUTLINED IN MILITARY SPECIFICATION MIL-A-6224, "ANTENNA FOR UHF AIRBORNE COMMUNICATIONS EQUIPMENT, GENERAL SPECIFICATION FOR DESIGN OF". THE ANTENNA WAS TESTED ON ULTRA HIGH FREQUENCIES OF 229.2, 316.2, AND 385.6 MEGACYCLES FOR RANGE, AUDIO QUALITY, AND SIGNAL STRENGTH, BOTH AIR-TO-AIR AND AIR-TO-GROUND.

THE TESTS REVEALED THAT ALTHOUGH THERE ARE SOME AREAS OF LOW SIGNAL STRENGTH FOUND FORWARD OF THE NOSE AND BENEATH THE WINGS OF THE AIRCRAFT, THE ANTENNA PROVIDES SATISFACTORY COMMUNICATIONS, BOTH AIR-TO-AIR AND AIR-TO-GROUND. THE RADIO FREQUENCY INPUT SIGNAL STRENGTH TO THE ANTENNA WAS GREATER AT ALL TIMES THAN THREE MICROVOLTS, WHICH WAS DETERMINED BY COMPONENTS AND SYSTEMS LABORATORY TO BE THE MINIMUM ACCEPTABLE SIGNAL STRENGTH INPUT FOR ADEQUATE COMMUNICATION RECEPTION. MAXIMUM RANGE OF THE ANTENNA WAS FOUND TO BE 260 STATUTE MILES WHILE FLYING ON AN AZIMUTH HEADING OF 180° FROM THE GROUND TEST STATION AND TRANSMITTING AT A FREQUENCY OF 229.2 MEGACYCLES, AND 240 STATUTE MILES WHILE FLYING ON AN AZIMUTH HEADING OF 180° FROM THE GROUND TEST STATION AND TRANSMITTING AT FREQUENCIES OF 316.2 AND 385.6 MEGACYCLES. AT ALL OTHER AZIMUTH HEADINGS, THE MAXIMUM USABLE RANGE WAS FOUND TO BE 210 STATUTE MILES AT ALL THREE TEST FREQUENCIES.

THE TITLE OF THIS REPORT IS UNCLASSIFIED.

PUBLICATION REVIEW

THIS REPORT HAS BEEN REVIEWED AND IS APPROVED.

FOR THE COMMANDING GENERAL:

for 
RICHARD S. CARTER
COLONEL, USAF

ACTING CHIEF, WEAPONS COMPONENTS DIVISION

WADC TR 52-144

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INTRODUCTION

Preliminary tests conducted on ultra high frequency tail cap antennas by civilian contractors have indicated that such antennas, when installed in USAF aircraft, have poor distribution in the forward hemisphere. This condition was reported to be particularly bad in the region from 0 to -30° below the nose of the aircraft.

First tests to be made by Wright Air Development Center on standard ultra high frequency antennas were conducted on an ultra high frequency tail cap antenna installed on an F-94A aircraft, (WADC TR No. 52-70, "Evaluation of Installation of UHF Tail Cap Antenna in F-94A Aircraft"). Next, tests were conducted on an ultra high frequency tail cap antenna installed on an F-89C aircraft, (WADC TR No. 52-104, "Evaluation of Installation of UHF Tail Cap Antenna in F-89 Type Aircraft").

Further tests were conducted on a standard ultra high frequency tail cap antenna, North American Aviation Part No. 161-23310-51, which was installed on an F-86A aircraft by North American Aircraft, Inc.. Flight tests were conducted at Wright-Patterson Air Force Base during the period between 20 February 1952 and 14 March 1952.

Since the structure and the radio installation of the F-86E aircraft are similar to the structure and radio installation of the F-86A, the results obtained from the tests on the F-86A will apply to the F-86E, also.

It is believed that the information obtained from these tests will be of assistance to other agencies concerned with the design, installation, and test of ultra high frequency antennas, and with the tactical utilization of the F-86A and E airplanes.

INSTALLATIONS

Installation of Equipment in Airplane

The ultra high frequency radio set AN/ARC-33 and the ultra high frequency tail cap antenna, North American Aviation Part No. 161-23310-51, were installed as a production change in an F-86A, AF Serial No. 48-253. The change consisted of the removal of radio set AN/ARC-3 and the associated cabling, wiring, and antenna, and the installation of: (1) Receiver-Transmitter RT 173/ARC-33 in approximately the same location in the radio compartment as were the Receiver R-77/ARC-3 and Transmitter T-67/ARC-3, (2) radio set control panel C-784/ARC-33 in the cockpit section, and (3) the associated wiring, terminal panels, junction boxes, and ultra high frequency tail cap antenna, North American Aircraft Part No. 161-23310-51.

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Receiver-Transmitter RT-173/ARC-33 was connected to the ultra high frequency tail cap antenna by approximately 20 feet of RG-9/U and 15 feet of RG-87/U high-temperature teflon radio-frequency coaxial cable. The tail cap antenna was located in the tip of the vertical stabilizer and was contained within a plastic housing. Figures 1 through 4 show relative positions of the old and new types of radio equipment installed in the F-86 aircraft. The position of the ultra high frequency tail cap antenna on the vertical stabilizer tip is shown in figure 5.

Installation of Ground Test Station

Ground station equipment radio set AN/GRC-27 consisted of one Radio Transmitter T-217/GR () having an indicated power output of 100-125 watts, and one Radio Receiver R-278/GR () having a sensitivity of 1 1/2 to 2 1/2 microvolts. The antenna which was used was antenna AS-505/GR (), commonly called, "Squirrel Cage UHF Antenna". The antenna was mounted 70 feet above the ground and connected to the AN/GRC-27 ground installation by an 80-foot frequency cable RG-17A/U.

The radio frequency signal intensities were measured across the automatic volume control to the ground in the Radio Receiver R-278/GR by means of a vacuum tube voltmeter. This voltage was then reduced to receiver input voltage by a calibrated signal source (Signal Generator Hewlett-Packard Model 608A) to produce the same automatic volume control to ground voltage. The relation

$$\frac{E_{in}}{E_{out}} = K$$

was used to obtain the conversion factor by which signal intensities, across the automatic volume control to ground, were reduced to receiver input intensity.

BENCH, PREFLIGHT, AND FLIGHT TESTS

Bench and Preflight Tests

Radio Set AN/ARC-33 was bench and preflight tested essentially in accordance with the tentative USAF Specification MIL-R-7238, "Radio Set AN/ARC-33, Bench, Preflight, and Flight Test of". The only deviation made from the specification was that the squelch circuit on the Receiver-Transmitter RT-173/ARC-33 was completely turned off. This was done to obtain more reliable signal strength recordings at the ground test station. Otherwise, the AN/ARC-33 was tested in accordance with the specification and was found to meet the requirements stated therein.

Flight Tests

1. General:

The evaluation of the ultra high frequency tail cap antenna was based upon flight test configurations as outlined in Specification MIL-A-6224, entitled "Antenna for UHF Airborne Communications Equipment, General Specification for Design of". The only deviation from the specification was to permit even more comprehensive tests than those required by the specification. The three

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assigned test frequencies for all flight tests were 229.2, 316.2, and 385.6 megacycles. Flight configurations which were flown were straight-line tests, clover-leaf patterns, 36-sided skid turn patterns, maximum range tests, and air-to-air tests.

2. Straight-Line Tests:

The flight test pattern for the straight-line tests is shown in figure 6, and Flight Test Record No. 1 (P.11) is the detailed description of the flight. The F-86A climbed to an altitude of 40,000 feet and assumed a 180-degree heading to the ground test station AF5XX directly below. The pilot then notified the ground station when he was at this position, and proceeded to fly on this heading for 50 nautical miles, reporting to the ground station every 30 seconds, while holding the carrier wave on for approximately three seconds. After reaching the 50-nautical mile point, the pilot executed a 180-degree turn and repeated the same procedure on a 0-degree heading. This test was made for all assigned test frequencies.

Results of the straight-line tests, shown in figures 7, 8, and 9, indicate that the signal strength recordings were never below the acceptable three-microvolt minimum. At both headings, when the aircraft was in an area of from one to two nautical miles from the ground test station AF5XX, there was a pronounced amount of garbling which made communication extremely variable. This condition of garbling did not prevail directly over the ground test station as it did in both the F-94A and F-89C tests, which probably can be attributed to the swept-back configuration of the empennage section of the aircraft. Communication was of a high degree of intelligibility at all other aircraft positions.

3. Clover-Leaf Patterns:

The typical flight pattern used to conduct the clover-leaf tests is illustrated in figure 10. (This figure shows a 45-degree pattern, while the tests included only 30-degree clover-leaf patterns.) The purpose of the clover-leaf tests was to determine signal strength data and the quality of communication at various azimuth headings and elevation angles to the ground test station. Tests were conducted at five different elevation angles from the ground station, and all three assigned test frequencies were used in each flight pattern.

Flight Test Record No. 2 (P.16) is the individual record of the pattern flown at the relatively high elevation angle of 30 degrees. Figures 11, 12, and 13 are the antenna signal strength plots for the three test frequencies of 229.2, 316.2, and 385.6 megacycles, respectively. Although the antenna signal strength plots indicate a slight nose null at all test frequencies, the results show that at no time were the recordings below the acceptable three-microvolt minimum, and communication was of a high quality throughout the tests.

Flight Test Record No. 3 (P. 21) is the detailed description of the 30-degree clover-leaf pattern flown at the elevation angle of 20 degrees, and figures 14, 15, and 16 are the signal strength plots for each of the three test frequencies. These plots show that although a slight nose null still existed, a more symmetrical pattern was obtained than was obtained in the test flown at a 30-degree elevation angle.

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Flight Test Record No. 4 (P.25) is the detailed report of the 30-degree clover-leaf pattern flown at an elevation angle of 10 degrees. Figures 17, 18, and 19 show the antenna signal strength plots for the tests flown at 229.2, 316.2, and 385.6 megacycles, respectively. Results again indicated that a shadowing of the antenna occurs off the nose of the aircraft, although the signal strength recordings were above the three-microvolt acceptable minimum at all times.

The detailed information of the 30-degree clover-leaf patterns flown at the low elevation angles of 2.35 and 1.1 degrees is recorded in flight test record No. 5, (P.29). Figures 20, 21, and 22 are the antenna signal strength plot patterns for the pattern flown at the 2.35-degree elevation angle, and figures 23, 24, and 25 are those flown at the 1.1-degree elevation angle. The results of these tests indicated that the antenna signal strengths were well above the three-microvolt acceptable minimum at all azimuth headings for both elevation angles.

4. 36-Sided Skid Turn Patterns:

Figure 26 illustrates the typical flight pattern used for the 36-sided skid-turn pattern tests, and figures 27, 28, and 29 are the antenna signal strength plots for the three assigned test frequencies, 229.2, 316.2, and 385.6 megacycles, respectively. These tests were conducted to further investigate the antenna radiation pattern at the low elevation angle of 1.1 degrees which was previously checked by flying a 30-degree clover-leaf pattern. Detailed information for this flight is recorded in flight test record No. 6, (P.36). The results obtained when these 36-sided skid turn patterns were being flown agree with those recorded for the 30-degree clover-leaf patterns in that a slight nose null was evident on all three test frequencies, although the signal strength recordings were above the three-microvolt minimum at all times.

5. Maximum Range Tests:

Maximum range tests were conducted to determine the maximum two-way communication range of the ultra high frequency tail cap antenna used in conjunction with radio set AN/ARC-33 installed on an F-86A aircraft. Detailed information of the flight is recorded in flight test record No. 7, (P.41).

The pilot flew at an altitude of 35,000 feet at a 180-degree heading from the ground station AF5XX, maintaining continuous contact with the station until the transmitted signal received at the station was just less than three microvolts. At this point, the pilot executed a 180-degree turn and flew a 0-degree heading to the station until the three-microvolt signal level was reached.

The maximum usable range of the ultra high frequency tail cap antenna on the F-86A aircraft was found to be 260-statute miles with a 180-degree heading to the station at 229.2 megacycles, 240-statute miles at a 180-degree heading to the station at both 316.2 and 385.6 megacycles, and 210-statute miles for all other azimuth headings to the ground station at all three test frequencies.

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6. Air-to-Air Test:

The flight pattern used for the air-to-air tests is shown in figure 30. The airborne test station, which was an F-89C aircraft equipped with an ultra high frequency tail cap antenna, flew a 35-mile radius circle around the ground test station at an altitude of 35,000 feet (see Fig. 30, track A). The F-86A airplane being tested was flown at an altitude of 15,000 feet in a 7 1/2-mile radius circle over a ground reference point which was 35 miles from the ground test station (see Fig. 30, track B). The pilots of the two aircraft maintained continuous two-way conversation with each other, reporting their locations and headings at all times. The ground test station recorded the conversation on tape. This pattern was flown for the three assigned test frequencies. A detailed account of the test is shown in Flight Test Record No. 8, (P. 42).

Results of this test revealed that the quality and strength of communication were very good at all times. It is important to note that the squelch circuit on the Receiver-Transmitter RT-173/ARC-33 was cut off as described in the section entitled "Bench and Preflight Tests" of this report, (P. 2).

CONCLUSIONS

Results of the flight tests can be summarized as follows:

A. The ultra high frequency tail cap antenna as installed in F-86A and E aircraft and used in conjunction with Radio Set AN/ARC-33 provides satisfactory two-way communication throughout the entire frequency band of the ultra high frequency communications equipment, at all ground station to aircraft elevation angles, at all azimuth headings, and in all positions of other aircraft above the F-86A and E aircraft.

B. It must be noted that it is most important to thoroughly check the ground station antenna pattern to determine the areas of low sensitivity resulting from improper antenna height and ground reflections.

RECOMMENDATIONS

It is recommended that the ultra high frequency tail cap antenna, North American Part No. 161-23310-51, be installed on all F-86A and E aircraft.

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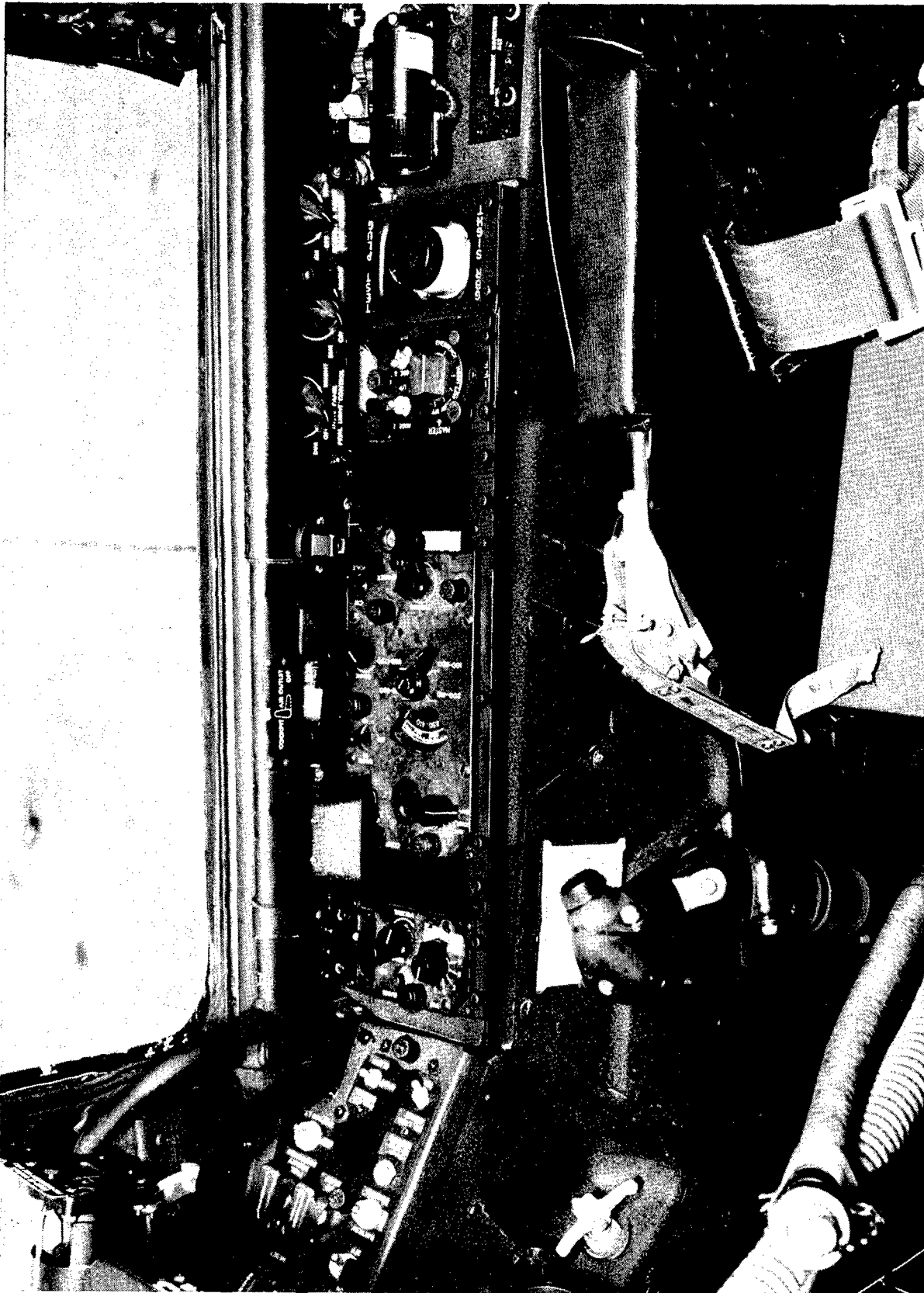


Fig. 1. Right-Hand Console with Control Panel C-404/ARC-3 Installed

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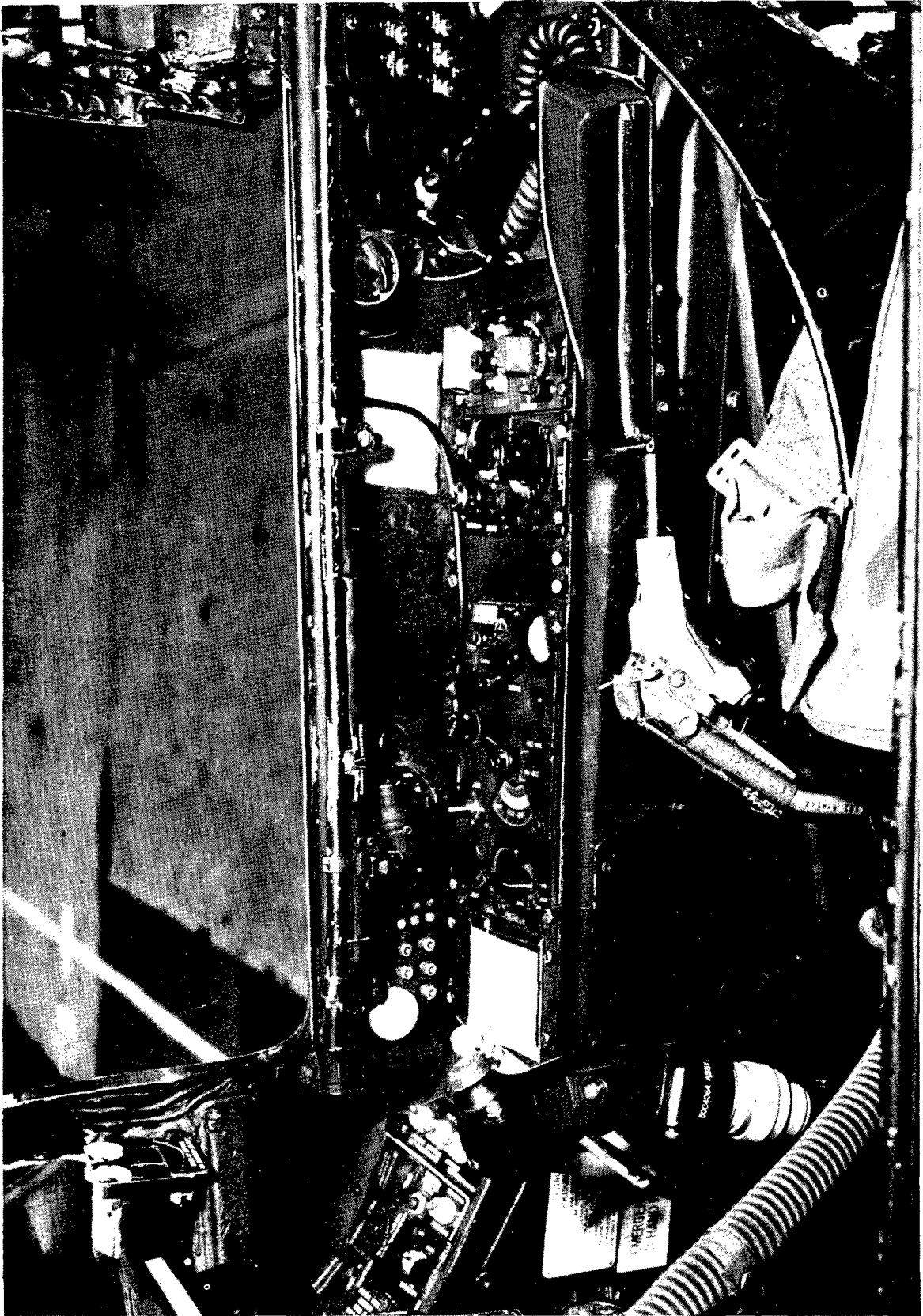


Fig. 2. Right-hand Console with Control Panel C-784/ARC-33 Installed

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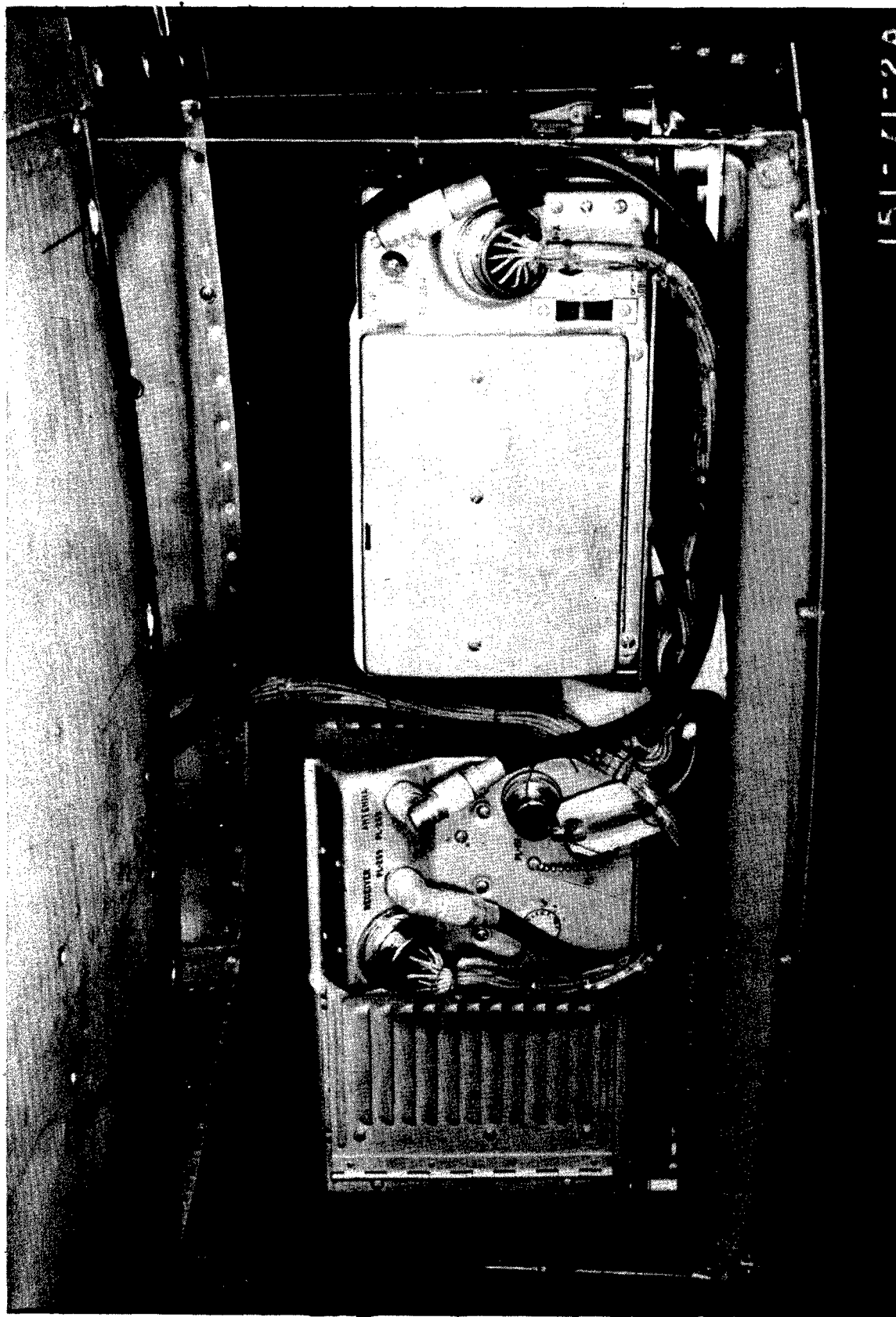


Fig. 3. Installation of Transmitter T-67/ARC-3 and Receiver R-77/ARC-3 on the Retractable Radio Support

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Fig. 4. Installation of Receiver-Transmitter RT-173/ARC-33 on Retractable Radio Support

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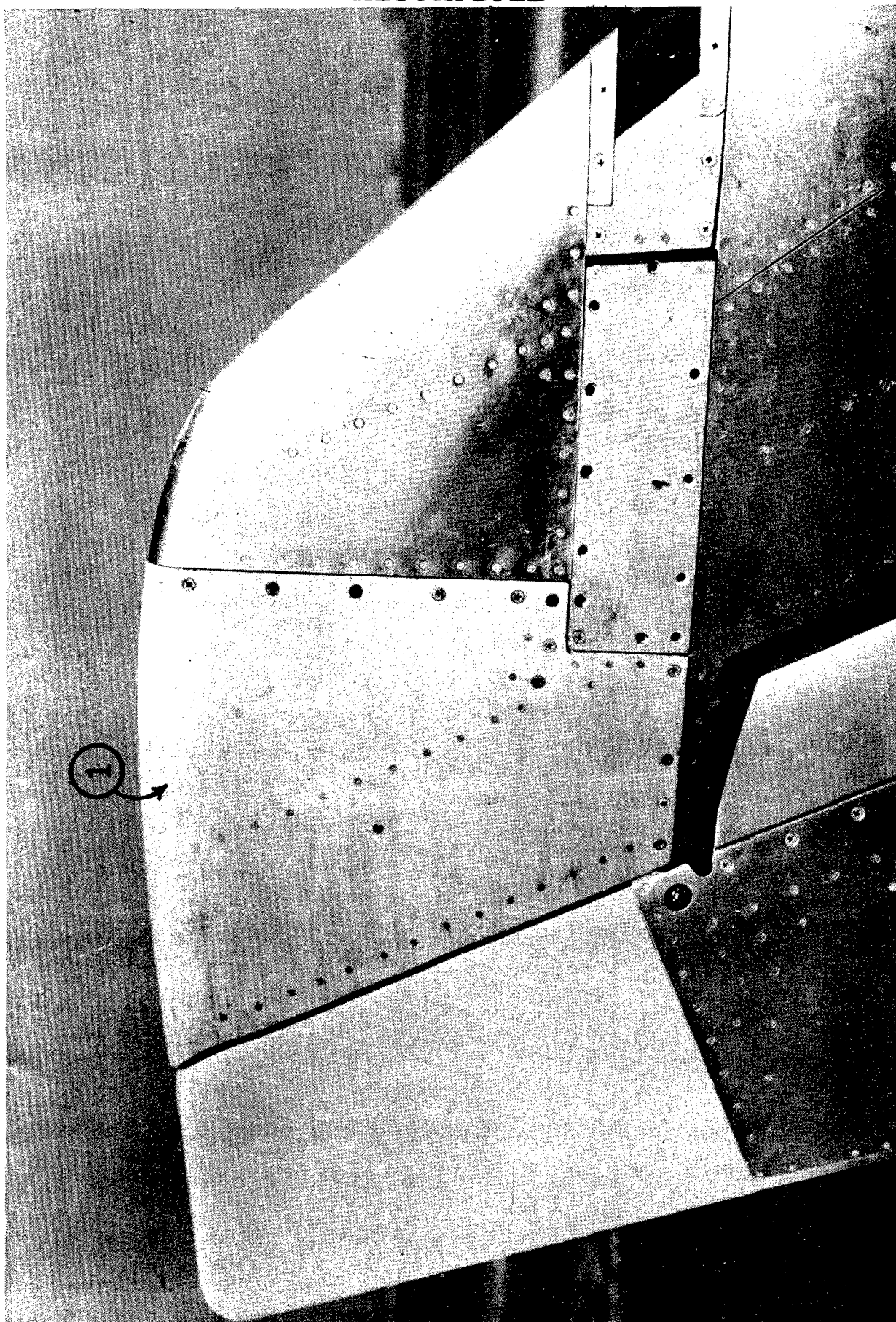


Fig. 5. Vertical Tip Assembly. (1) Housing for UHF Tail Cap Antenna

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FLIGHT TEST RECORD NO. 1

Airplane Type and No...F-86A,
AF No...48-253

Project...UHF Tail Cap Antenna
Evaluation, Straight Line Tests

Flight No.....1

E.O. No.....S-102-54

Date....26 February 1952

Time....

Take-off.....0901

Location.....Local

Landing.....1104

Max. Altitude....40,000 ft.

Total Flight....2+03

Total on Equip..2+03

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To obtain signal strength data and to check on the quality of two-way communication off the nose and tail of the aircraft at various elevation angles from ground test station AF5XX.

Test Procedure and/or Flight Program: The pilot climbed to 40,000 ft. and assumed a position directly over the ground test station AF5XX. At this point, the pilot notified the ground test station, then proceeded to fly 180° from the station, reporting every 30 seconds. This procedure continued until the aircraft was 50 nautical miles from the ground test station, where the pilot executed a 180° turn and flew a 0° heading to the ground test station, again reporting every 30 seconds. The ground test station recorded the signal strengths received. This test was conducted at test frequencies of 229.2, 316.2, and 385.6 megacycles.

Test Data and/or Results: The signal strength recordings were good throughout the three frequencies tested at all elevation angles to the ground test station. Communication was excellent during the tests except at points between one and two miles of the ground station where garbling occurred.

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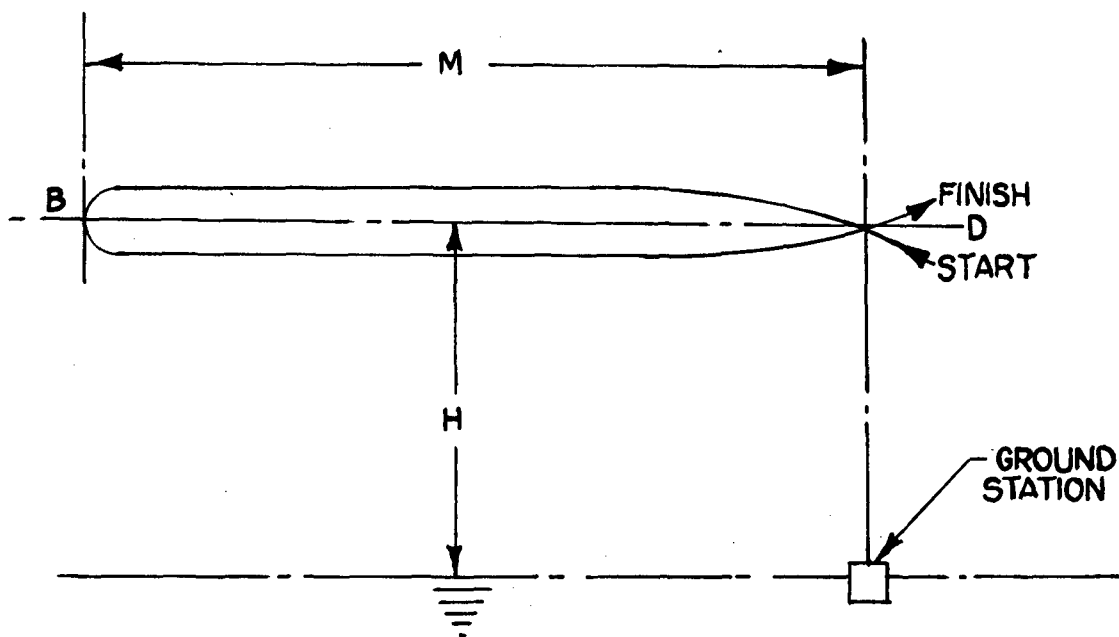


Fig. 6. Straight Line Tests to and from Ground Test Station

BD = Actual Flight Path of Aircraft

M = 50 Nautical Miles

H = Altitude of Flight Path = 41,000 ft.(Pressure)

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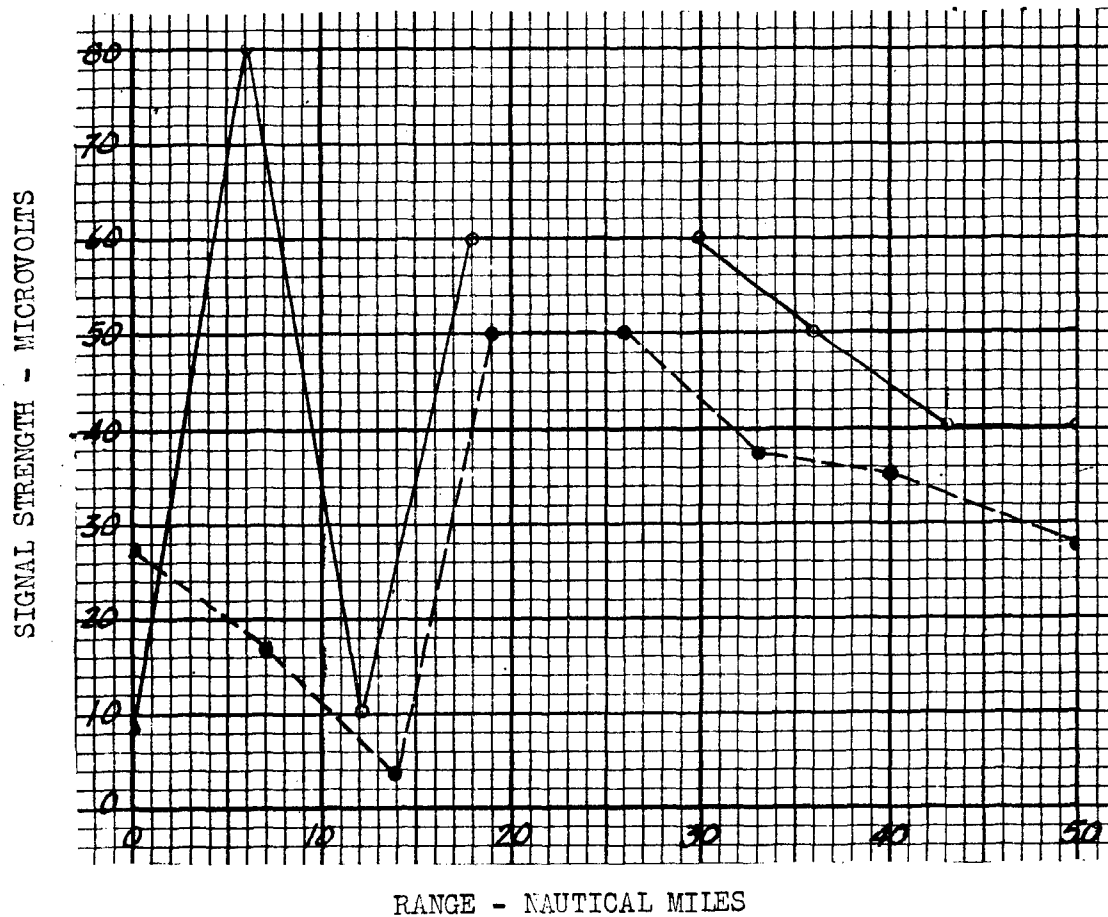


Fig. 7. Straight-Line Tests to and from Ground Test Station
229.2 Megacycles

KEY
- - - - - Nose Heading
_____ Tail Heading

Aircraft - F-86A AF No. 48-253
Date - 12 March 1952

Pilot - Lt. W. A. Ross
Operator - W. E. Luginbuhl

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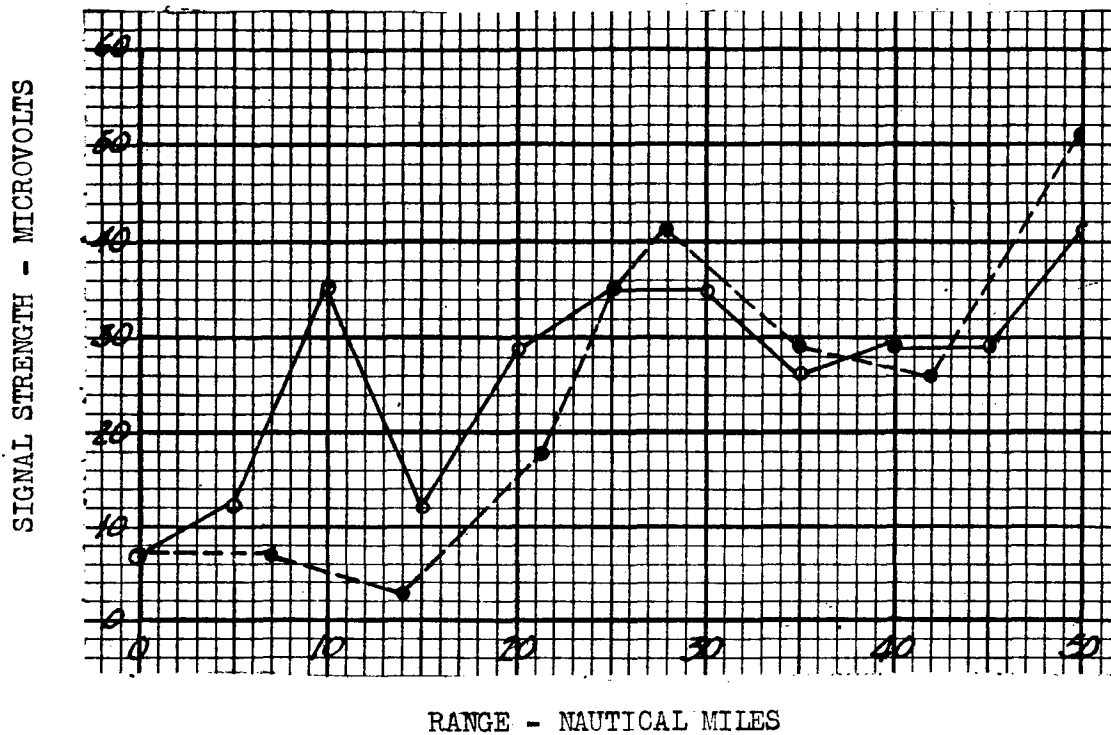


Fig. 8. Straight-Line Tests to and from Ground Test Station
316.2 Megacycles

KEY
- - - -Nose Heading
_____Tail Heading

Aircraft - F-86A AF No. 48-253
Date - 12 March 1952

Pilot - Lt. W. A. Ross
Operator - W. E. Luginbuhl

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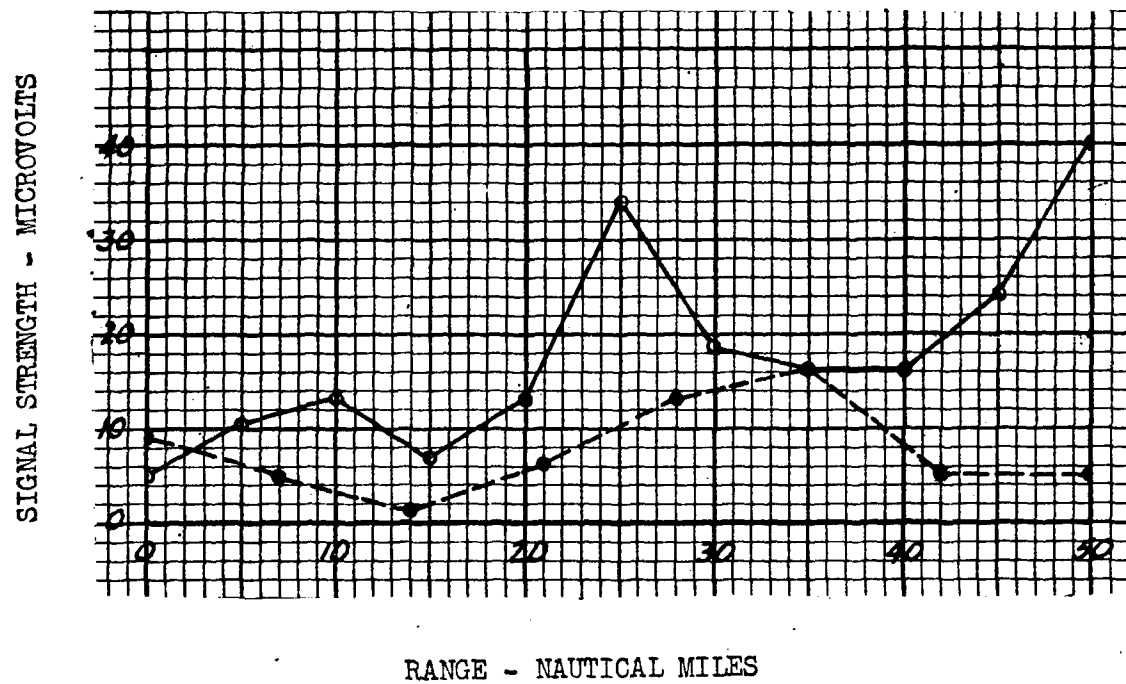


Fig. 9. Straight-Line Tests to and from Ground Test Station
385.6 Megacycles

KEY
- - - - -Nose Heading
_____Tail Heading

Aircraft - F-86A AF No. 48-253
Date - 12 March 1952

Pilot - Lt. W. A. Ross
Operator - W. E. Luginbuhl

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FLIGHT TEST RECORD NO. 2

Airplane Type and No...F-86A,
AF No.48-253

Project...UHF Tail Cap Antenna
Evaluation, 30° Clover Leaf
Pattern Tests

Flight No.....2

E.O. No.....S-102-54

Date.....26 February 1952

Time....

Take-off.....1230

Location.....Local

Landing.....1345

Max. Altitude....40,000 ft.

Total Flight....1+15

Total on Equip..1+15

Weather.....VFR

Pilot..1st Lt. W.A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To obtain signal strength recordings and to check the quality of two-way communication while flying at various azimuth bearings and at an elevation angle of 30° to the ground test station AF5XX.

Test Procedure and/or Flight Program: The pilot climbed to 40,000 ft. at a point 12.5 nautical miles from ground station AF5XX, flew a 30° clover leaf pattern over this point, and reported to the ground test station on every leg of the pattern over the ground reference point. The ground station recorded the signal strength data. This test was conducted at test frequencies of 229.2, 316.2, and 385.6 megacycles.

Test Data and/or Results: The signal strength recordings were good, and all were above the acceptable three microvolt minimum. The quality of the two-way communication was good at all three test frequencies.

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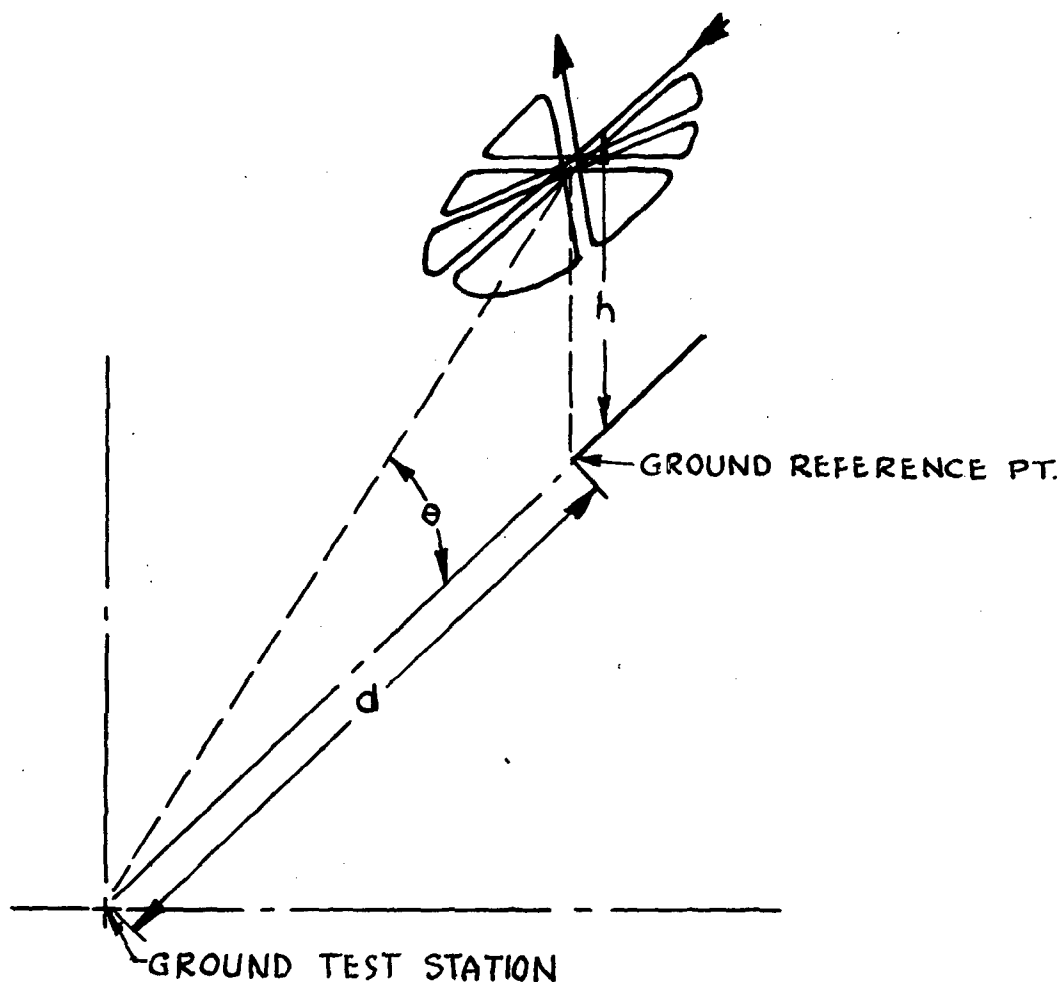


Fig. 10. Clover-Leaf Test Pattern

h = Altitude of flight pattern
 d = Distance of ground reference point to ground test station
 θ = Arc $\tan \frac{h}{d}$ = ground station to aircraft elevation angle

NOTE: Pattern illustrated is a 45° Clover-Leaf, while the patterns flown for the subject tests were 30° Clover-Leaf.

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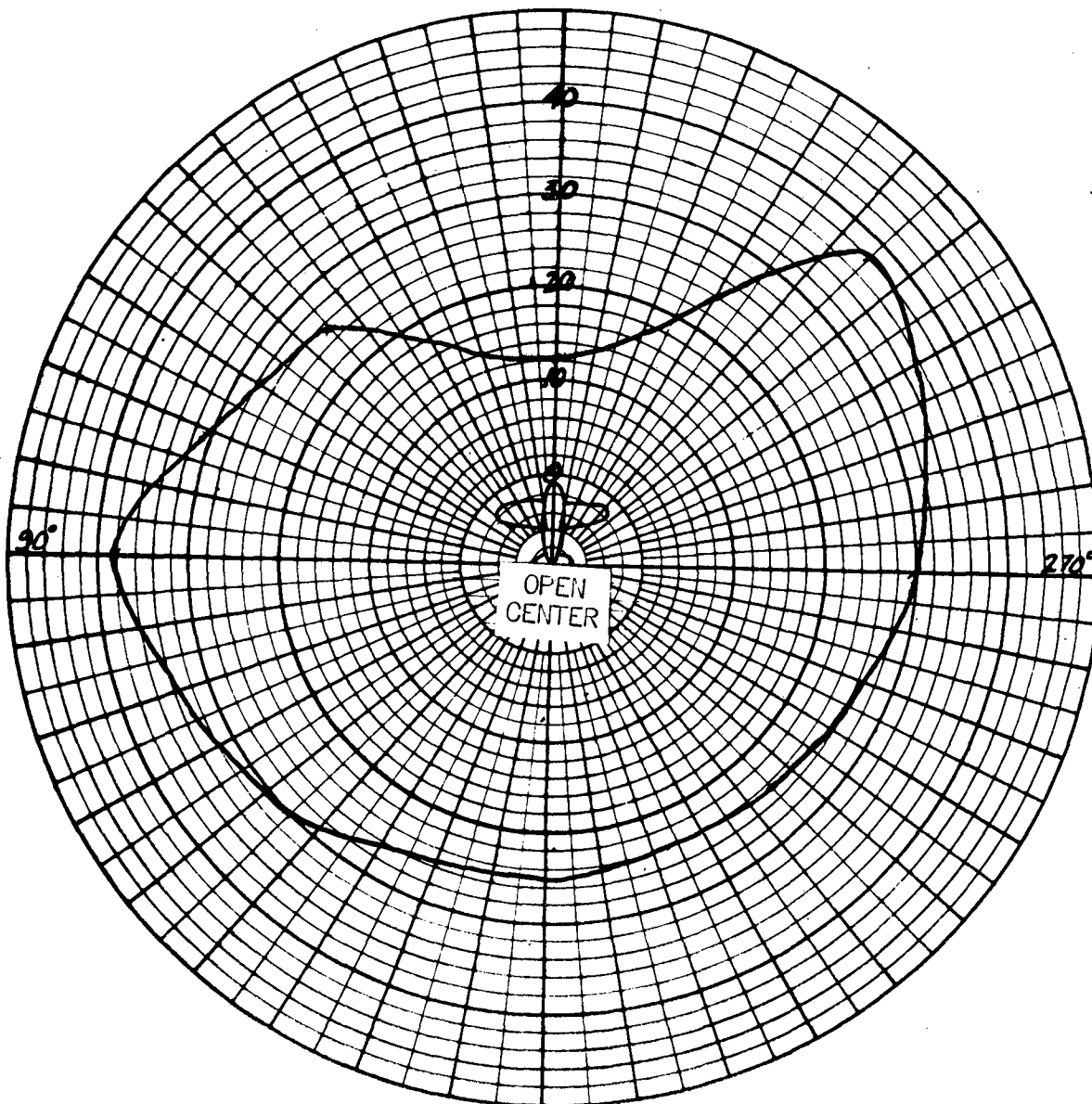


Fig. 11 30° Clover-Leaf Pattern, 229.2 Megacycles, Elevation Angle 30°

Scale: 1 Division \approx 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 12.5 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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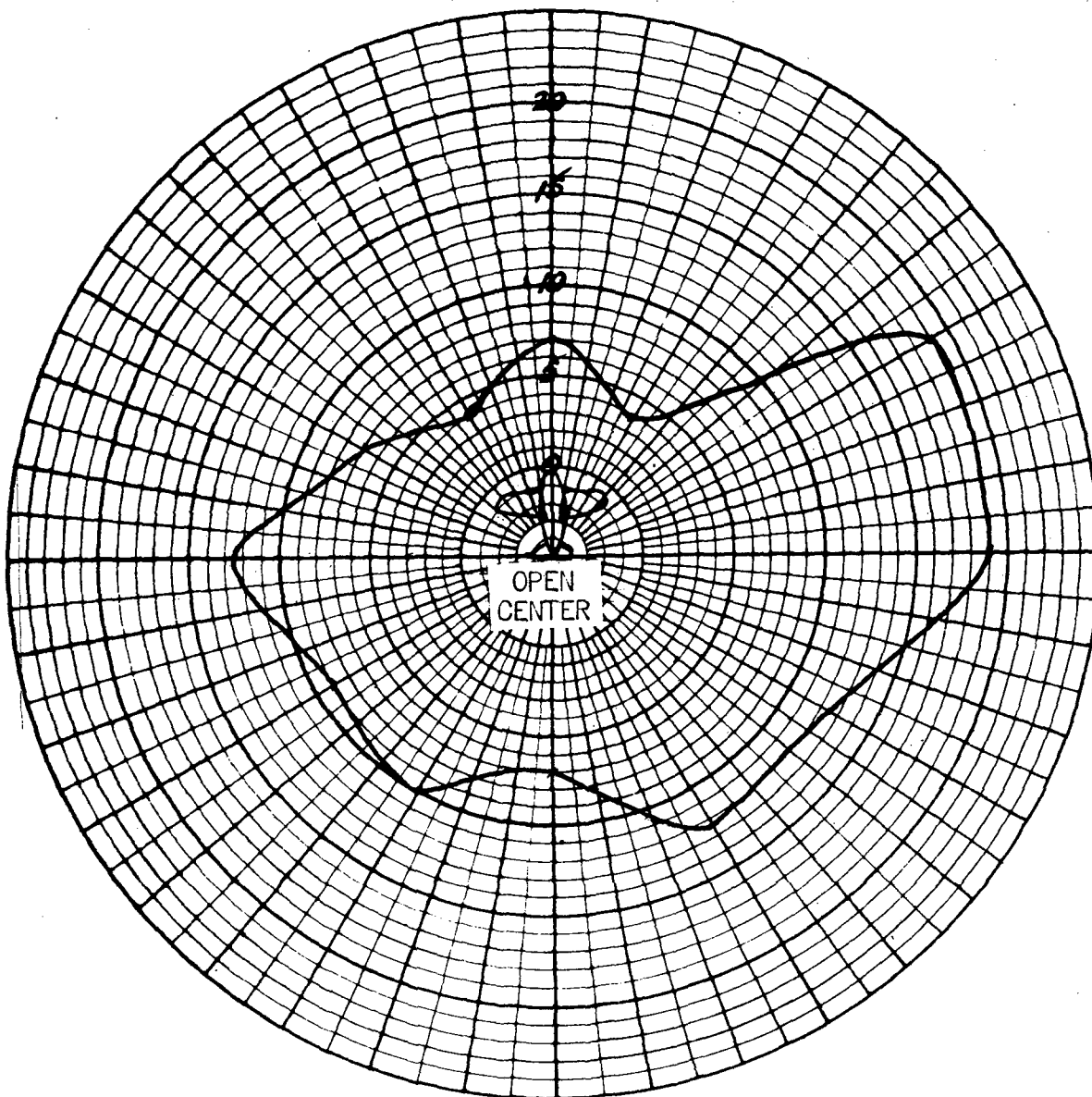


Fig. 12 30° Clover-Leaf Pattern, 316.2 Megacycles, Elevation Angle 30°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 12.5 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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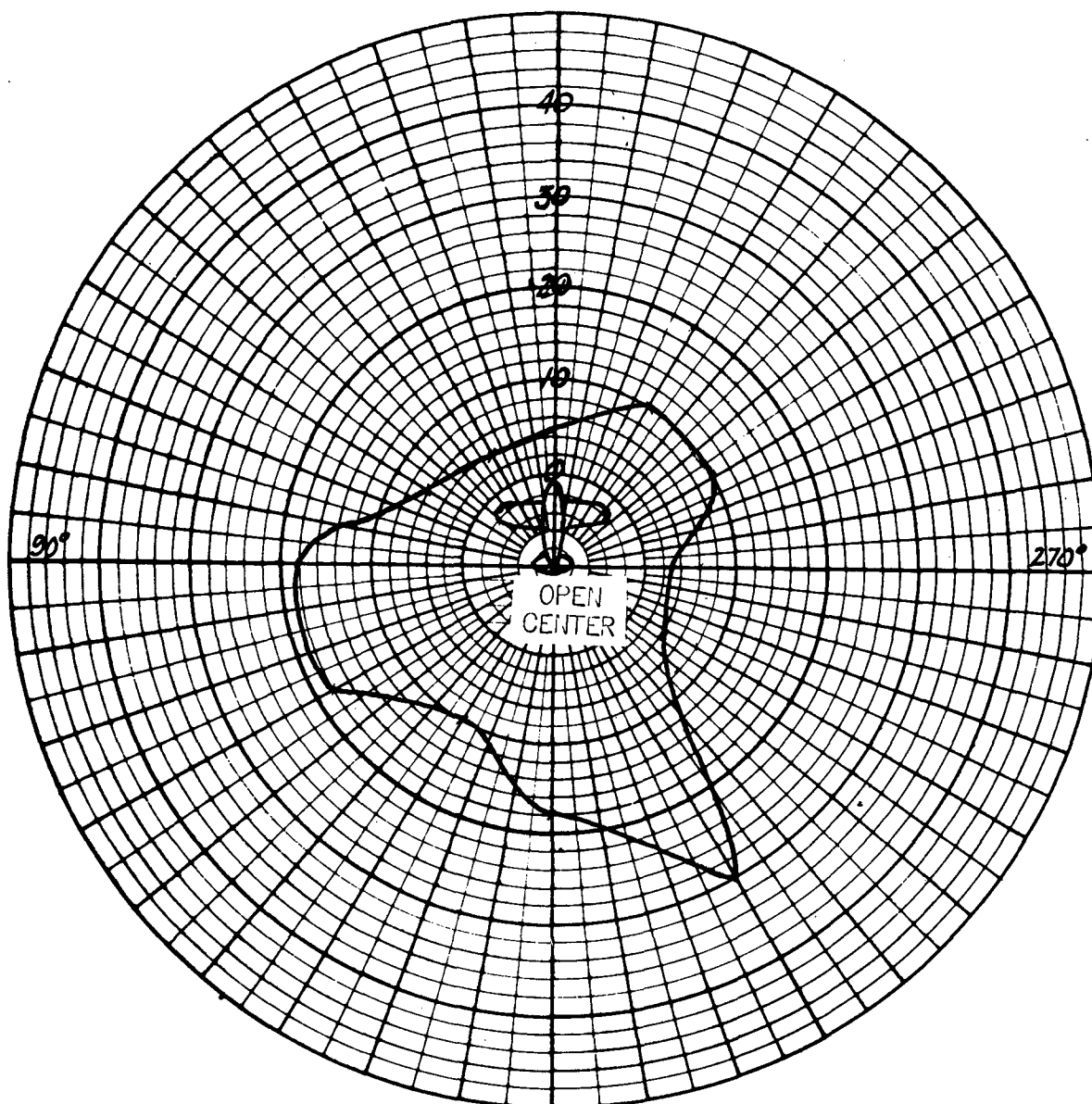


Fig. 13 30° Clover-Leaf Pattern, 385.6 Megacycles, Elevation Angle 30°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 12.5 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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FLIGHT TEST RECORD NO. 3

Airplane Type and No....F-86A,
AF No..48-253

Project...UHF Tail Cap Antenna
Evaluation, 30° Clover Leaf
Pattern Tests

Flight No......3

E.O. No......S-102-54

Date.....27 February 1952

Time....

Take-off.....0825

Location.....Local

Landing.....1015

Max. Altitude.....40,000 ft.

Total Flight....1+55

Total on Equip..1+55

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft

Purpose or Description of Flight: To obtain signal strength data and to check the quality of two-way communication at various azimuth bearings and at a 20° elevation angle to the ground test station.

Test Procedure and/or Flight Program: The pilot climbed to 40,000 ft. and flew to a point 20 nautical miles from ground station AF5XX. This point was the ground reference point where 30° clover-leaf patterns were flown at the three test frequencies of 229.2, 316.2, and 385.6 megacycles. The pilot reported to the ground test station on each leg of each pattern over the ground reference point. The ground test station recorded the signal strength data.

Test Data and/or Results: The signal strength recordings were all well above the acceptable three-microvolt minimum, and the quality of communication at all times was very good.

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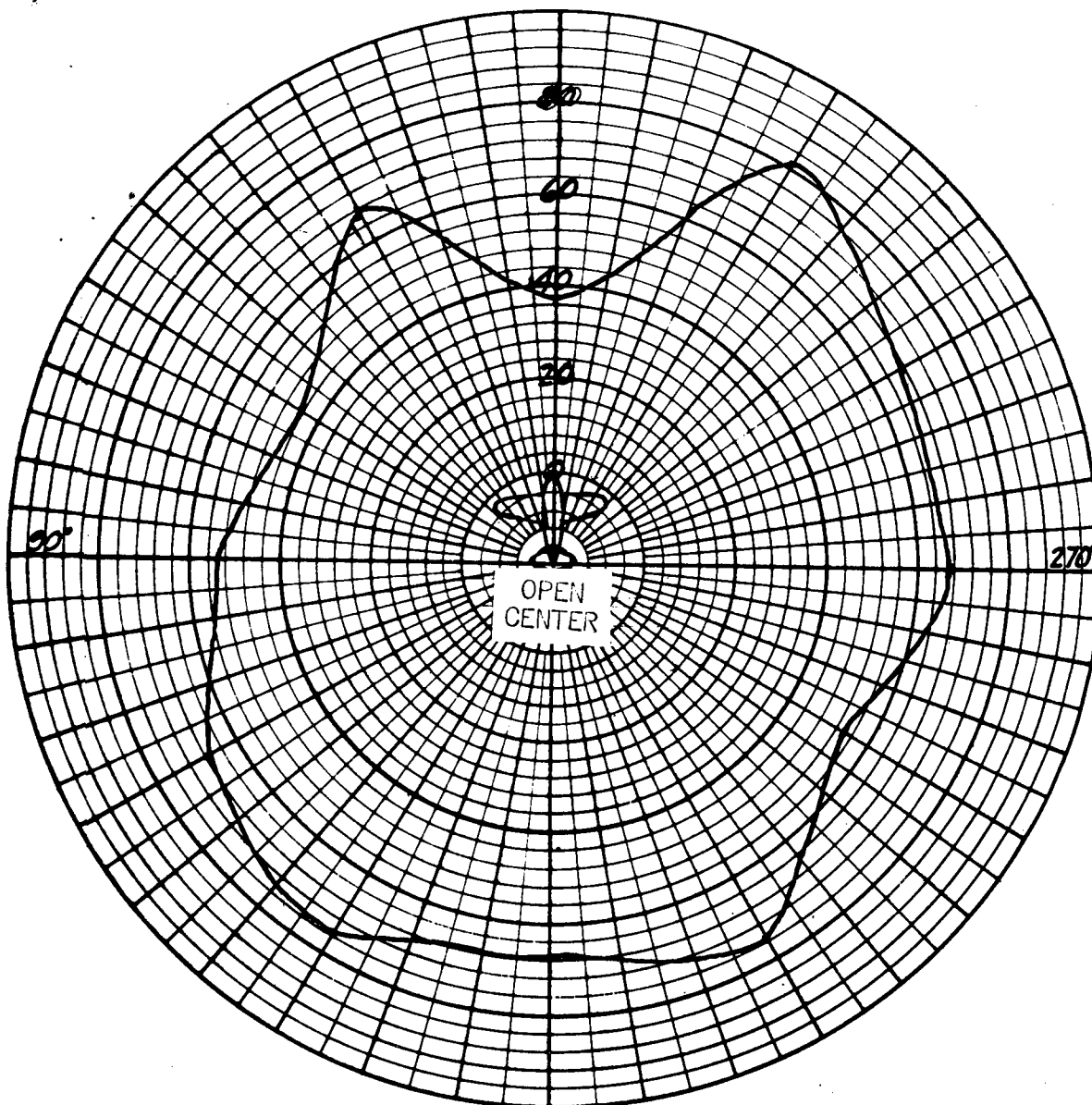


Fig. 14 30° Clover-Leaf Pattern, 229.2 Megacycles, Elevation Angle 20°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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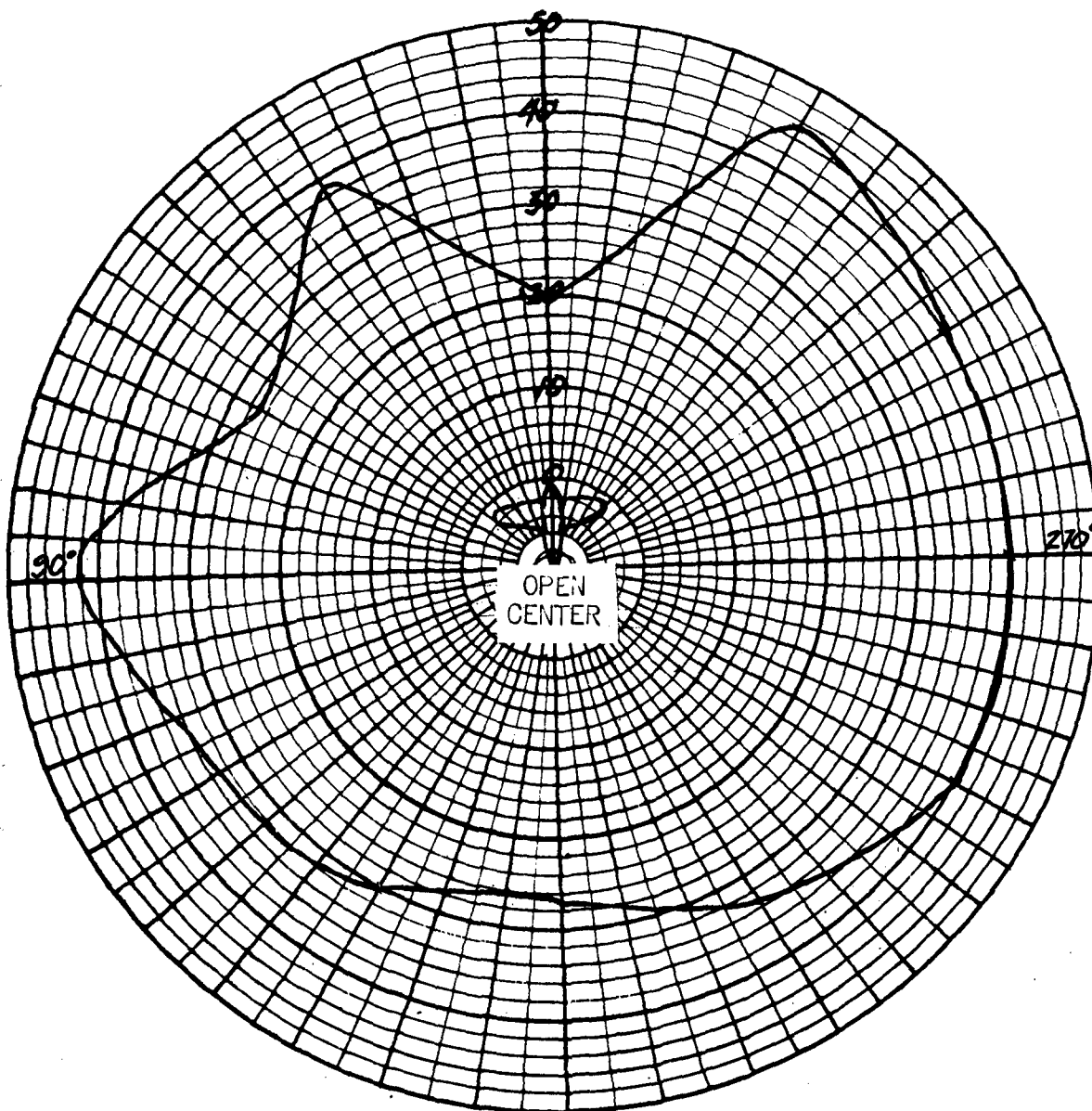


Fig. 15 30° Clover-Leaf Pattern, 316.2 Megacycles, Elevation Angle 20°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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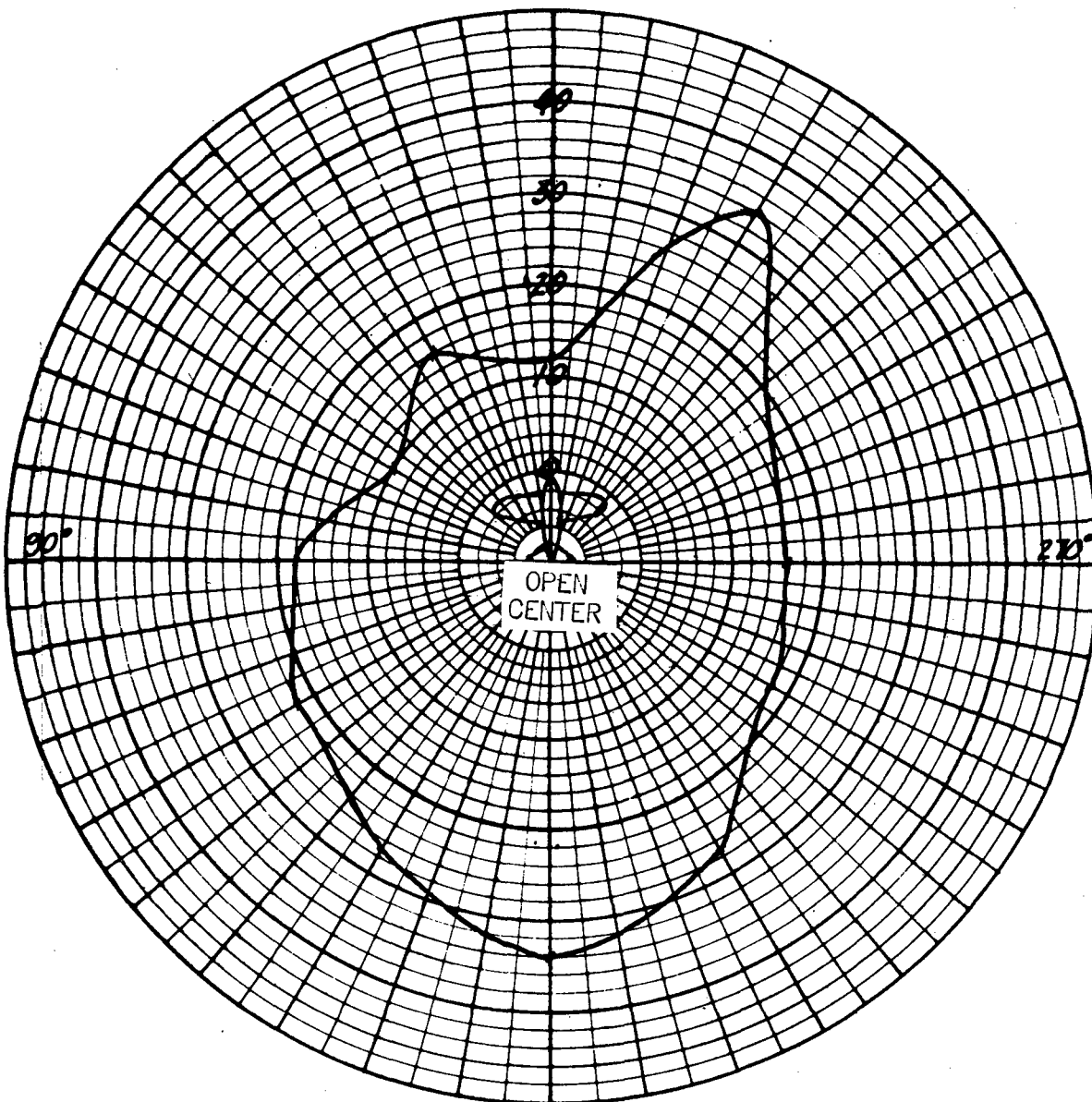


Fig. 16 30° Clover-Leaf Pattern, 385.6 Megacycles, Elevation Angle 20°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 40,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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FLIGHT TEST RECORD NO. 4

Airplane Type and No....F-86A,
AF No..48-253

Project...UHF Tail Cap Antenna
Evaluation, 30° Clover-Leaf
Pattern Tests

Flight No......4

E.O. No......S-102-54

Date.....27 February 1952

Time.....

Take-off.....1500

Location.....Local

Landing.....1615

Max. Altitude....35,000 ft.

Total Flight....1+15

Total on Equip..1+15

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver- Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To obtain signal strength data, and to check the quality of two-way communication at various azimuth bearings and at an elevation angle of 10° from the ground test station.

Test Procedure and/or Flight Program: The pilot climbed to 35,000 ft. and flew to a point 33 nautical miles from the ground test station AF5XX. Using this point as a ground reference point, the pilot flew 30° clover-leaf patterns at 229.2, 316.2, and 385.6 megacycles, and reported the azimuth heading to the ground test station on each leg of each pattern. The ground station recorded the signal strength data.

Test Data and/or Results: The recorded signal strengths were all above the minimum acceptable strength of three microvolts, and the quality of the two-way communications was very good at all times.

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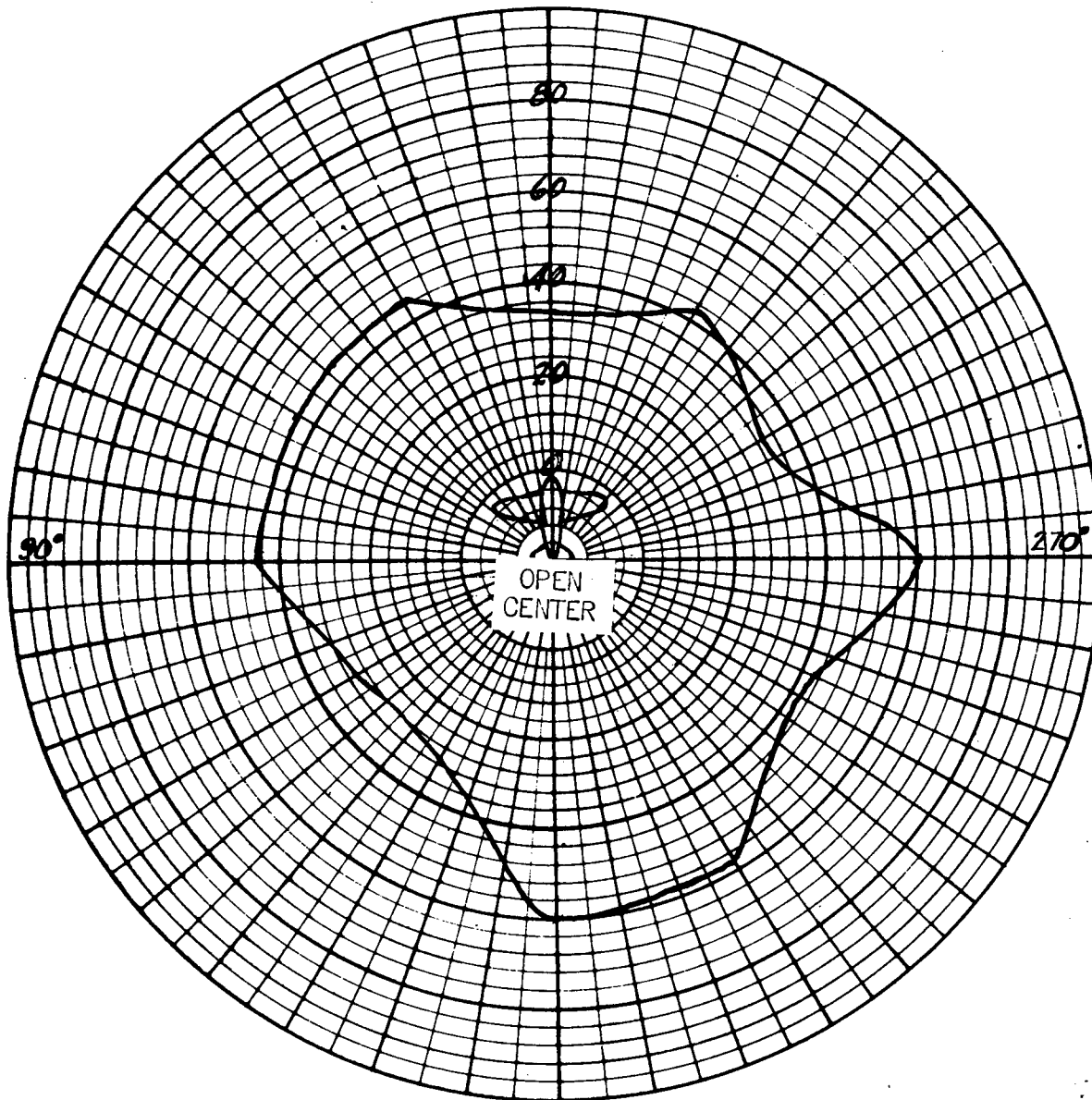


Fig. 17 30° Clover-Leaf Pattern, 229.2 Megacycles, Elevation Angle 10°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 35,000 ft. (Pressure)
Distance - 34 nautical miles
Date - 28 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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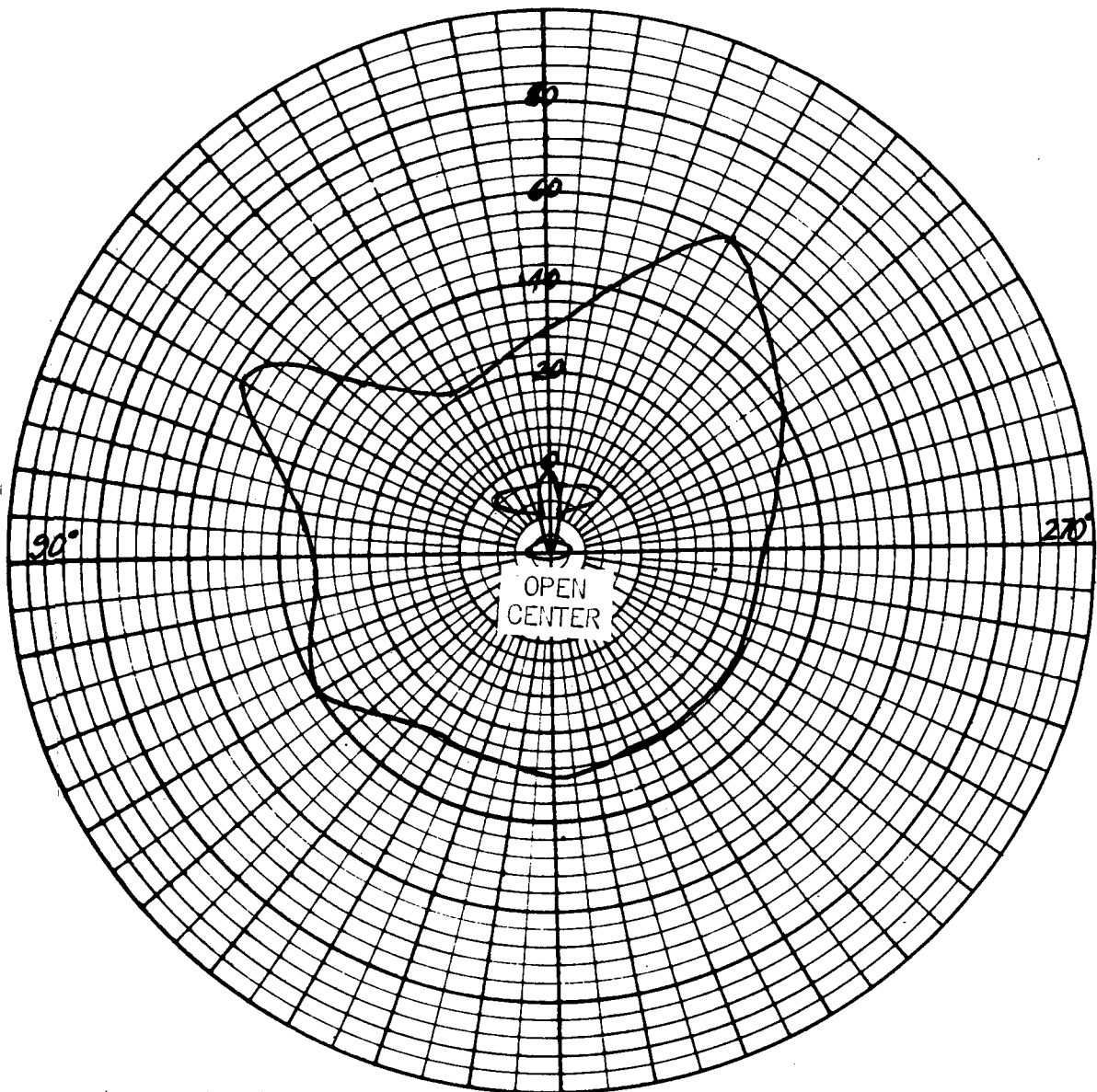


Fig. 18 30° Clover-Leaf Pattern, 316.2 Megacycles, Elevation Angle 10°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 35,000 ft. (Pressure)
Distance - 34 nautical miles
Date - 28 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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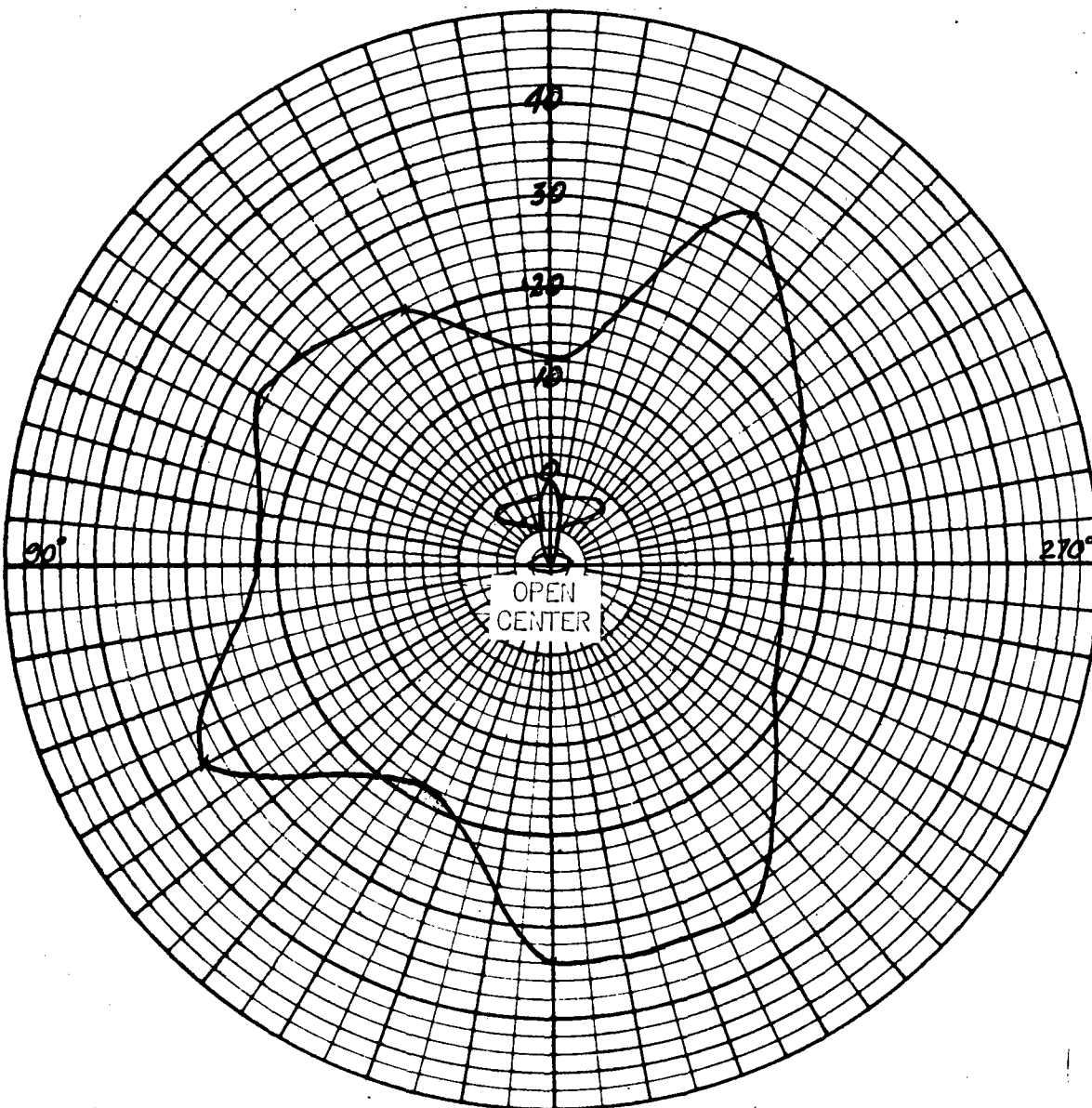


Fig. 19 30° Clover-Leaf Pattern, 385.6 Megacycles, Elevation Angle 10°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 35,000 ft. (Pressure)
Distance - 34 nautical miles
Date - 23 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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FLIGHT TEST RECORD NO. 5

Airplane Type and No....F-86A,
AF No...48-253

Project...UHF Tail Cap Antenna
Evaluation, 30° Clover-Leaf
Pattern Tests

Flight No......5

E.O. No......S-102-54

Date.....28 February 1952

Time....
Take-off.....0813

Location.....Local

Landing.....0945

Max. Altitude....6,000 ft.

Total Flight....1+32

Total on Equip..1+32

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To obtain signal strength data and to check the quality of two-way communication at various azimuth bearings and at the two elevation angles of 2.35° and 1.1° from the ground test station.

Test Procedure and/or Flight Program: The pilot climbed to an altitude of 6,000 ft. and flew 30° clover-leaf patterns at the three test frequencies of 229.2, 316.2, and 385.6 megacycles at distances of 20 and 40 nautical miles from the ground test station. The pilot reported the azimuth heading on each leg of each pattern over the ground reference points and ground station AF5XX recorded the signal strength data.

Test Data and/or Results: The results revealed that the radiation pattern of the tail cap antenna at all test frequencies, azimuth headings, and the two elevation angles, was well above the three-microvolts acceptable minimum. The quality of communications was good at all times during the test flights.

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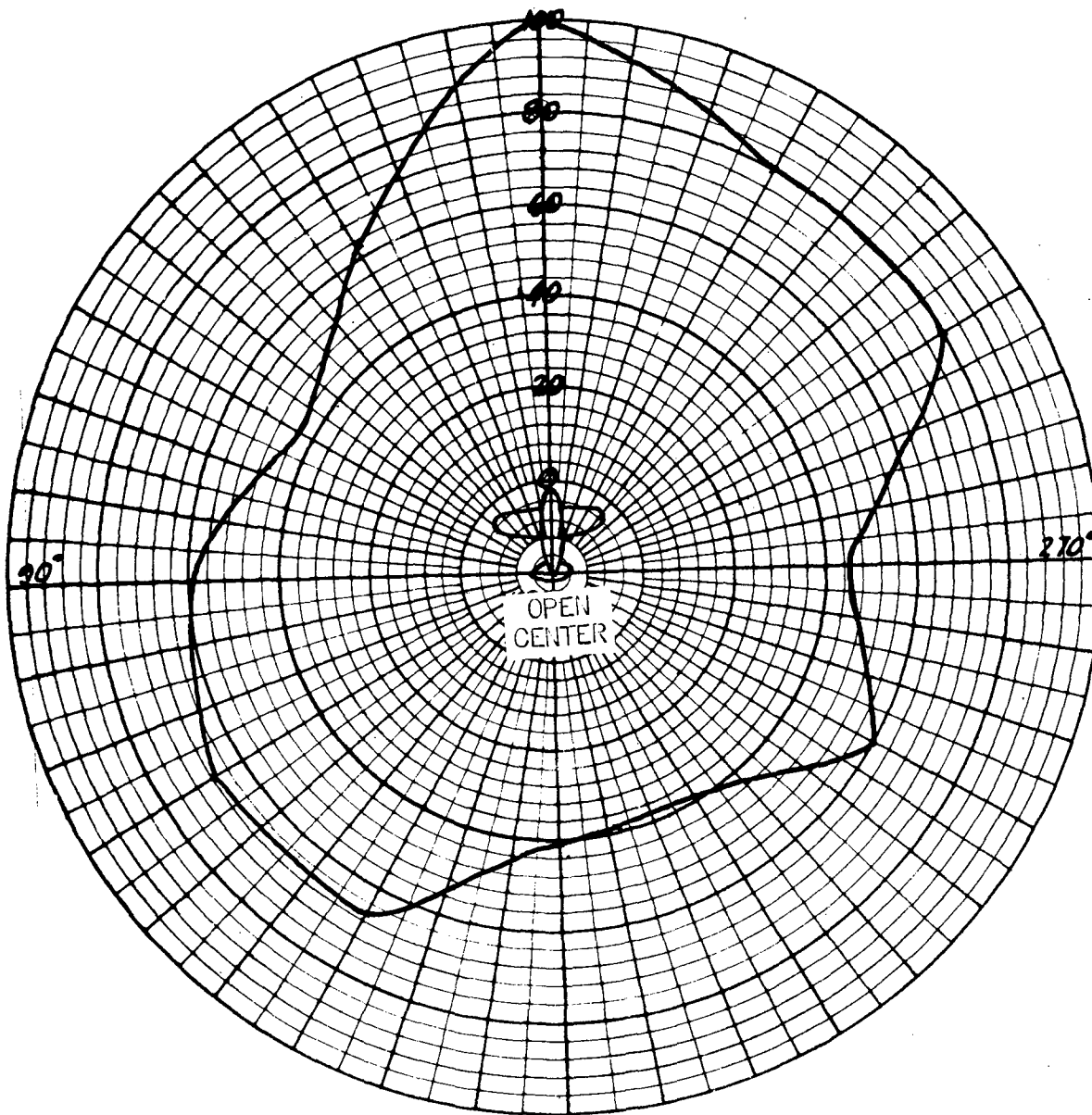


Fig. 20 30° Clover-Leaf Pattern, 229.2 Megacycles, Elevation Angle 2.35°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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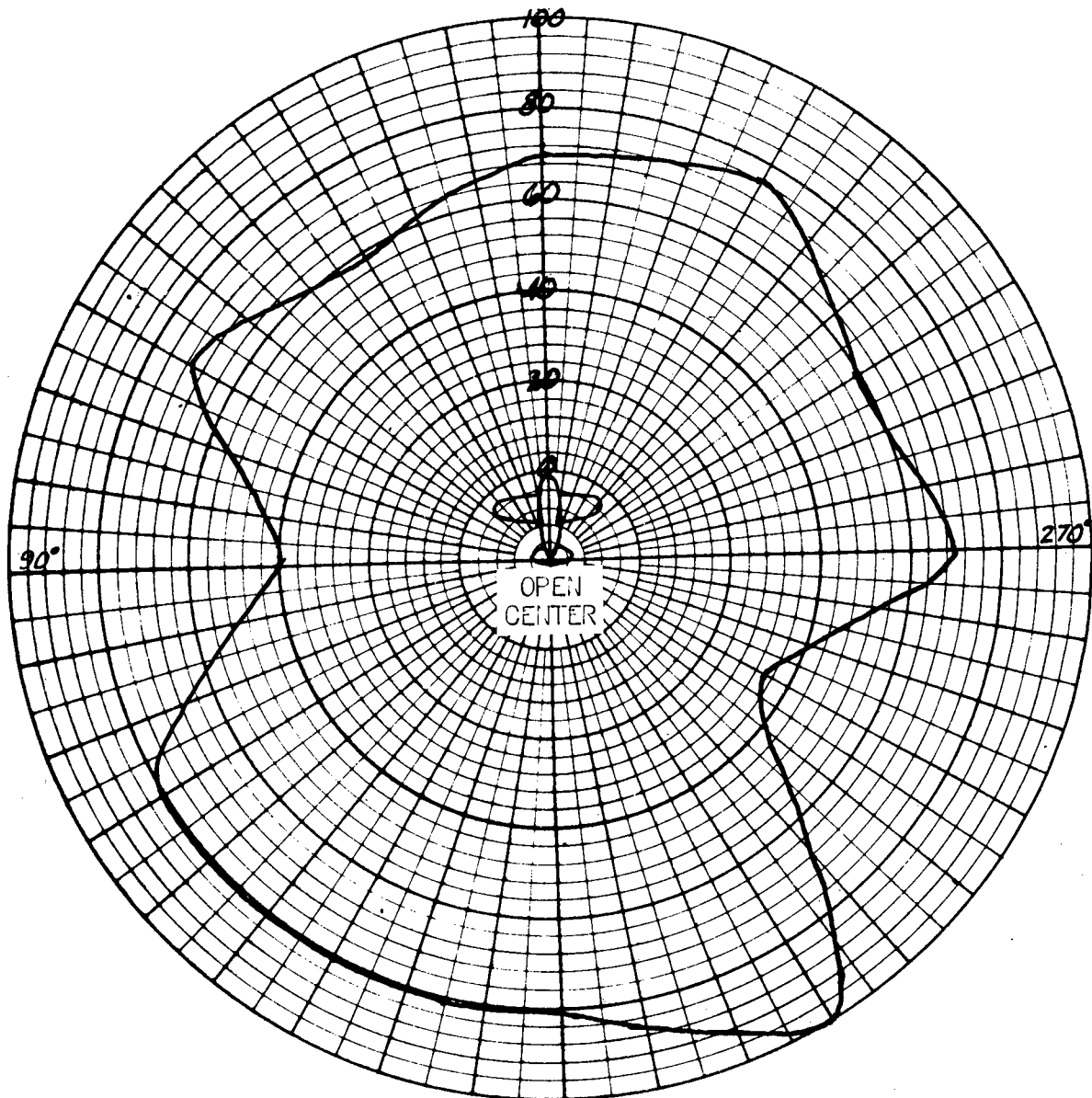


Fig. 21 30° Clover-Leaf Pattern, 316.2 Megacycles, Elevation Angle 2.35°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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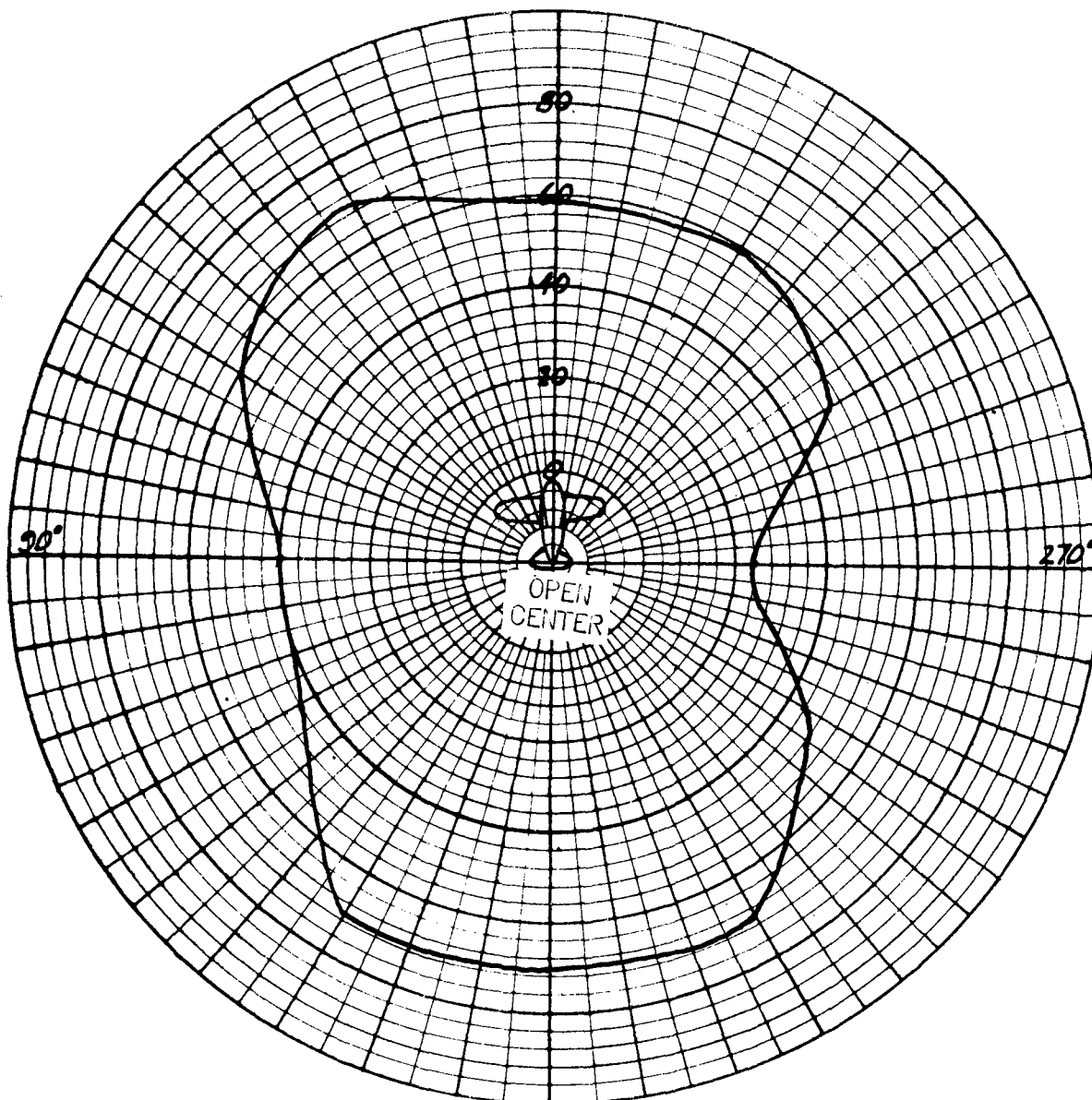


Fig. 22 30° Clover-Leaf Pattern, 385.6 Megacycles, Elevation Angle 2.35°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 20 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Lubinbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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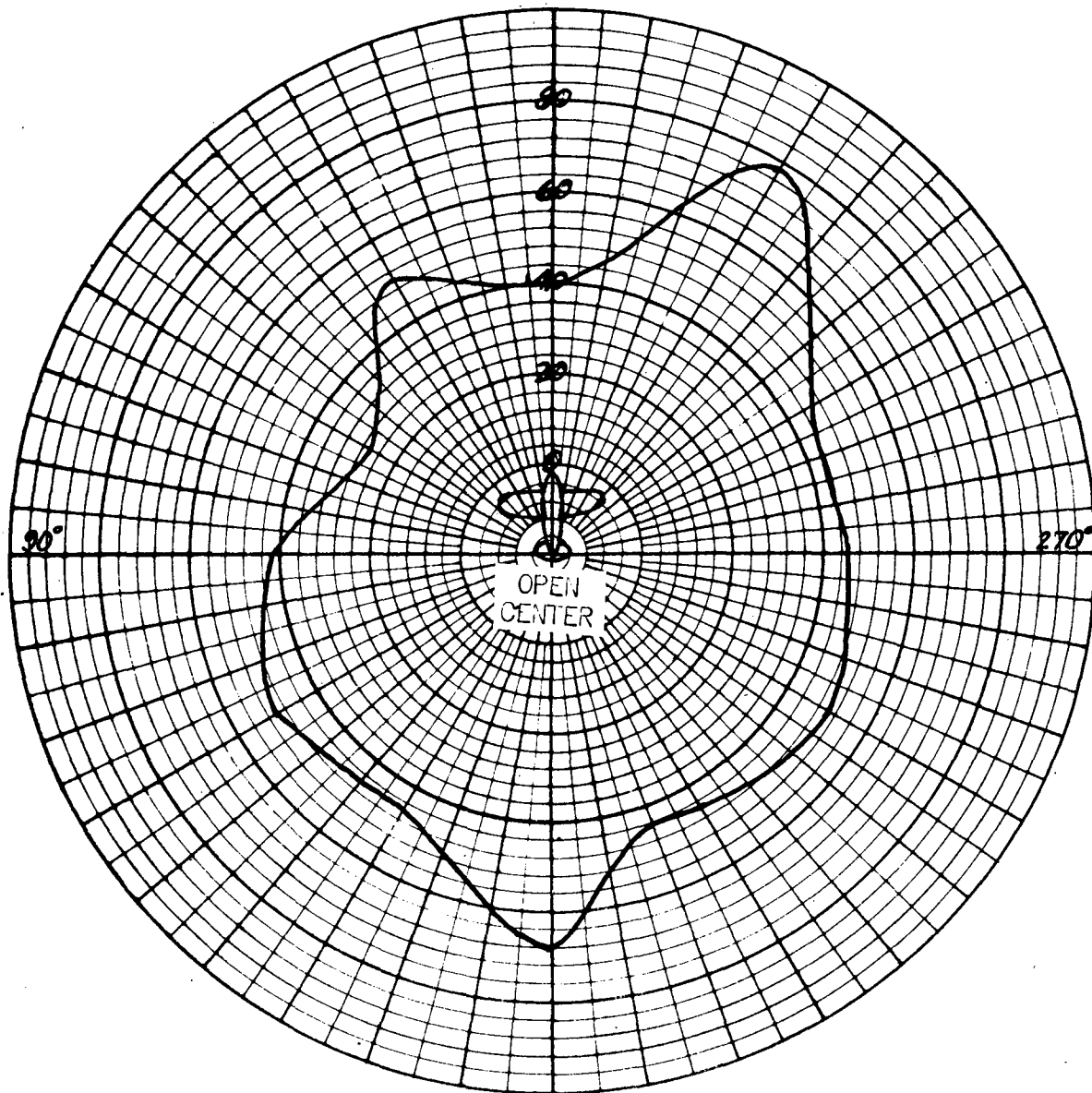


Fig. 23 30° Clover-Leaf Pattern, 229.2 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 40 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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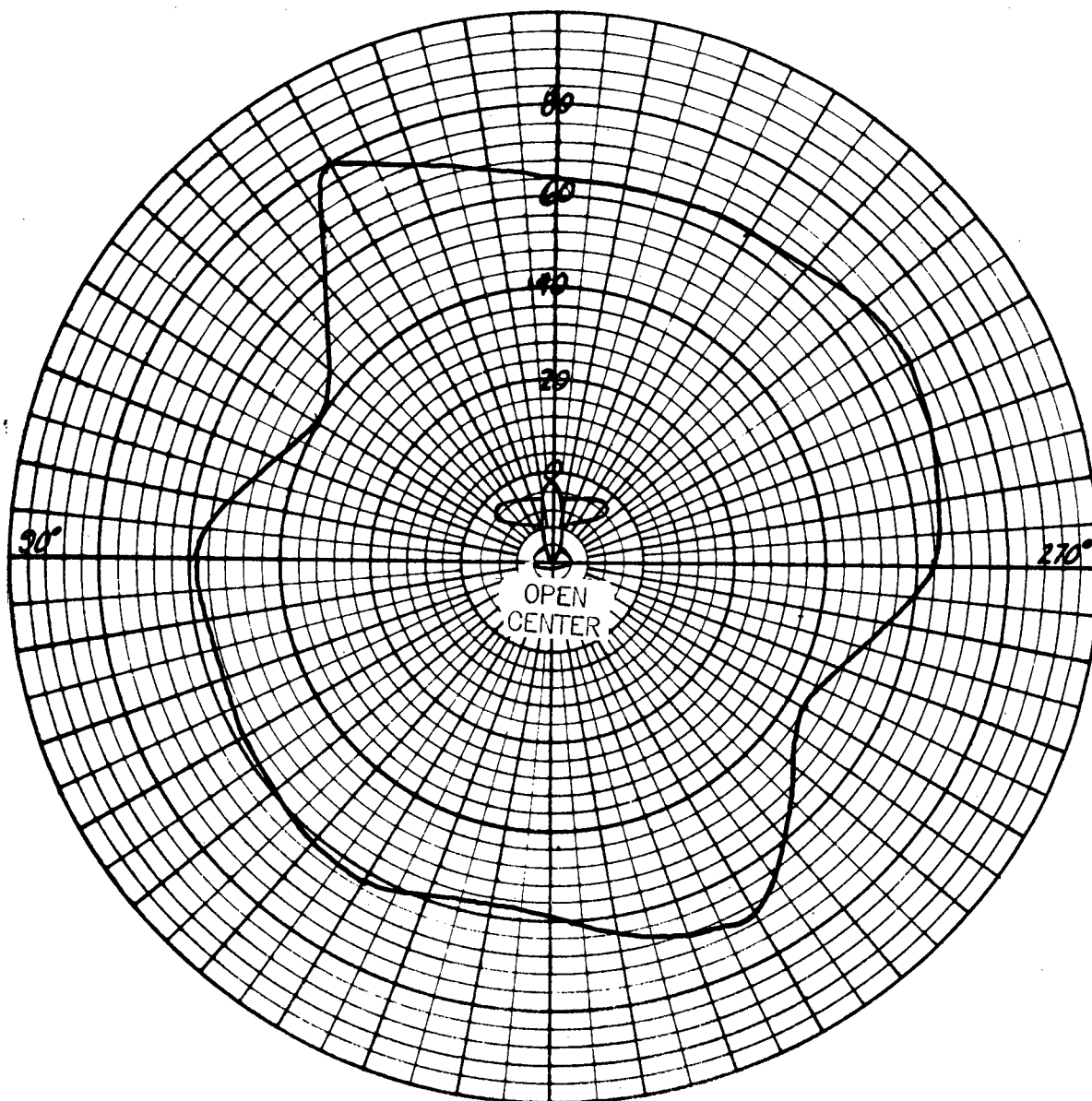


Fig. 24 30° Clover-Leaf Pattern, 316.2 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 40 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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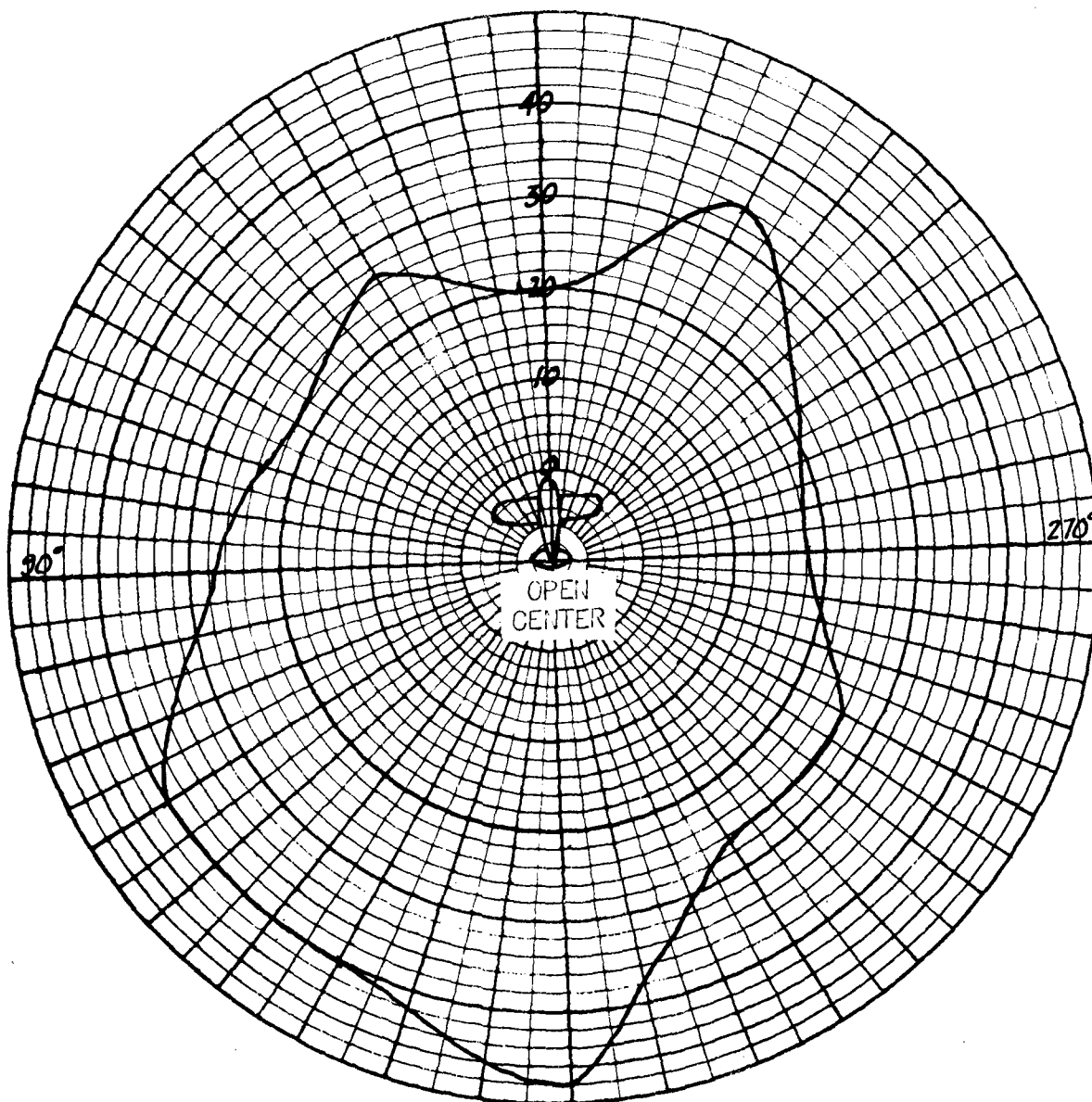


Fig. 25 30° Clover-Leaf Pattern, 385.6 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 4 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 6,000 ft. (Pressure)
Distance - 40 nautical miles
Date - 26 February 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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FLIGHT TEST RECORD NO. 6

Airplane Type and No....F-86A,
AF No..48-253

Project...UHF Tail Cap Antenna
Evaluation, 36-Sided Skid Turn
Pattern Tests

Flight No......6

E.O. No......S-102-54

Date....28 February 1952

Time....

Take-off.....1320

Location.....Local

Landing.....1435

Max. Altitude....11,000 ft.

Total Flight....1+15

Total on Equip..1+15

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To obtain signal strength data and to check the quality of two-way communication at various azimuth headings and at a low elevation angle of 1.1° from the ground test station AF5XX.

Test Procedure and/or Flight Program: The pilot climbed to 11,000 ft. and flew to a ground reference point of 86 nautical miles from the ground test station AF5XX. Over this point the pilot flew 36-sided skid turn patterns, using the test frequencies of 229.2, 316.2, and 385.6 megacycles. The ground test station recorded the signal strength data.

Test Data and/or Results: The test data revealed that although some slight null areas did exist forward of the nose and off the wings of the aircraft, the signal strength recordings were well above the three-microvolt minimum, and the quality of communications was good at all times.

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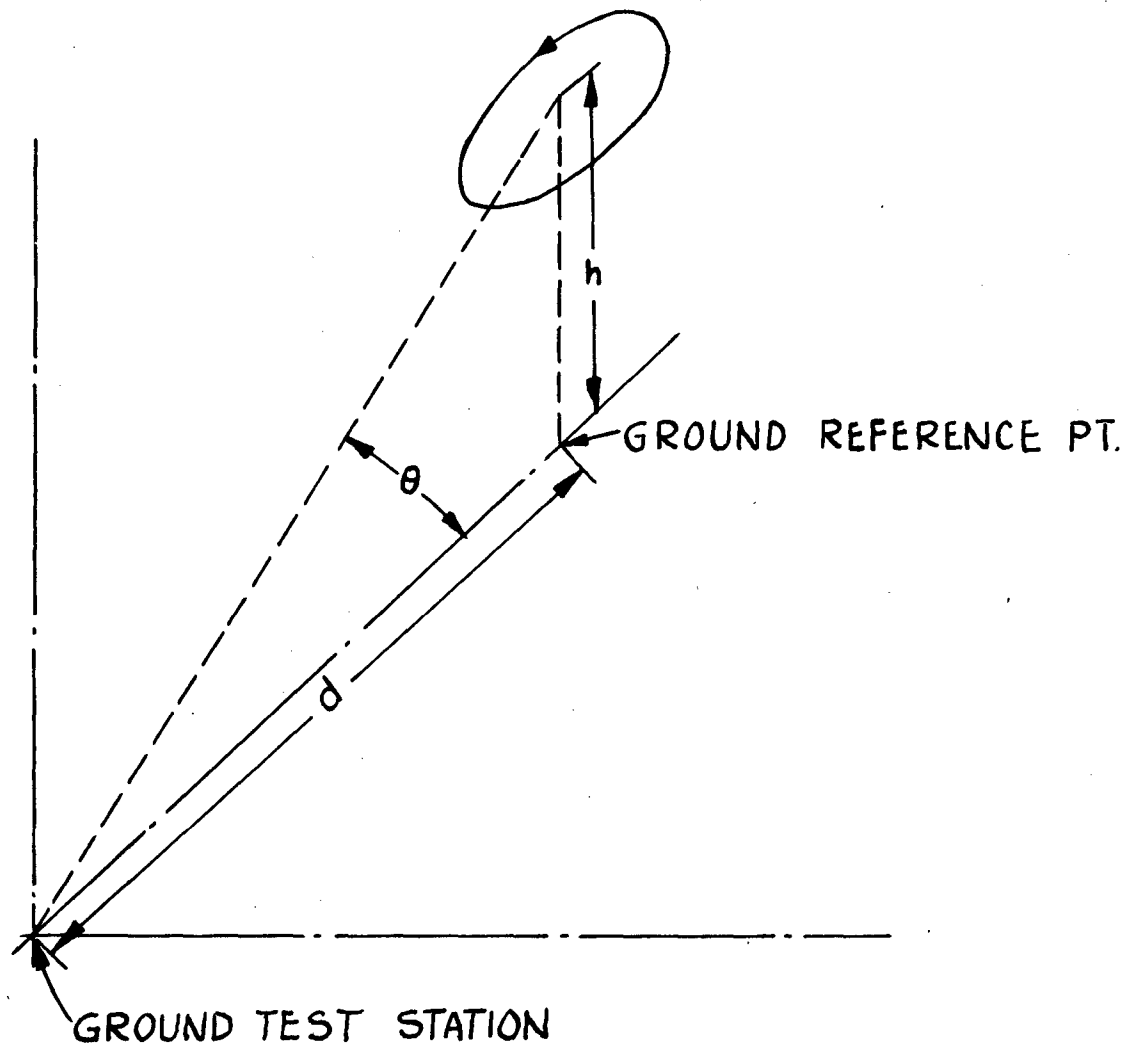


Fig. 26. 36-Sided Skid Turn Test Pattern

h = Altitude of flight pattern

d = Distance of ground reference point to ground test station

θ = Arc $\tan \frac{h}{d}$ = ground station to aircraft elevation angle

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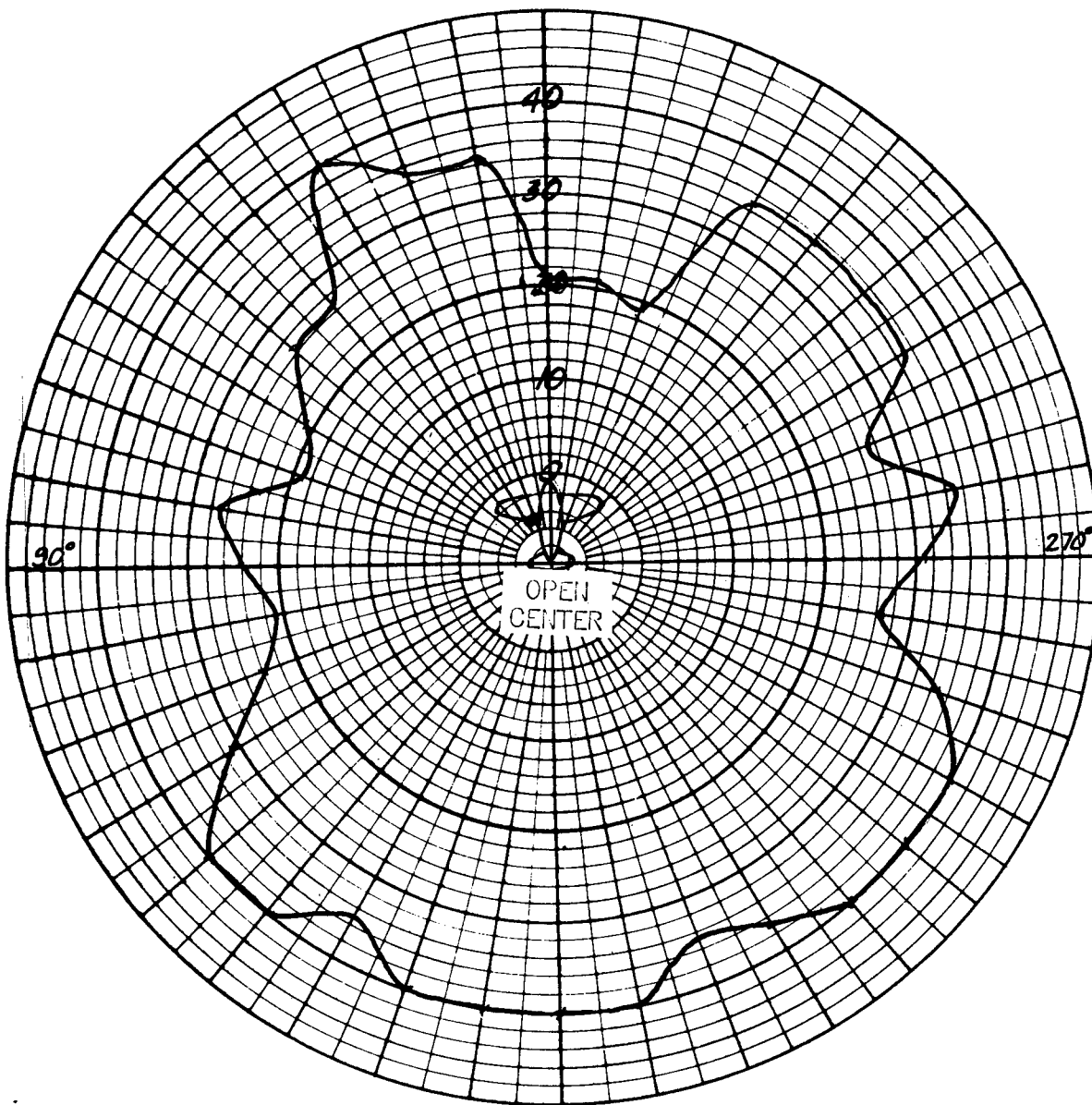


Fig. 27 36-Sided Skid Turn Pattern, 229.2 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 11,000 ft. (Pressure)
Distance - 86 nautical miles
Date - 7 March 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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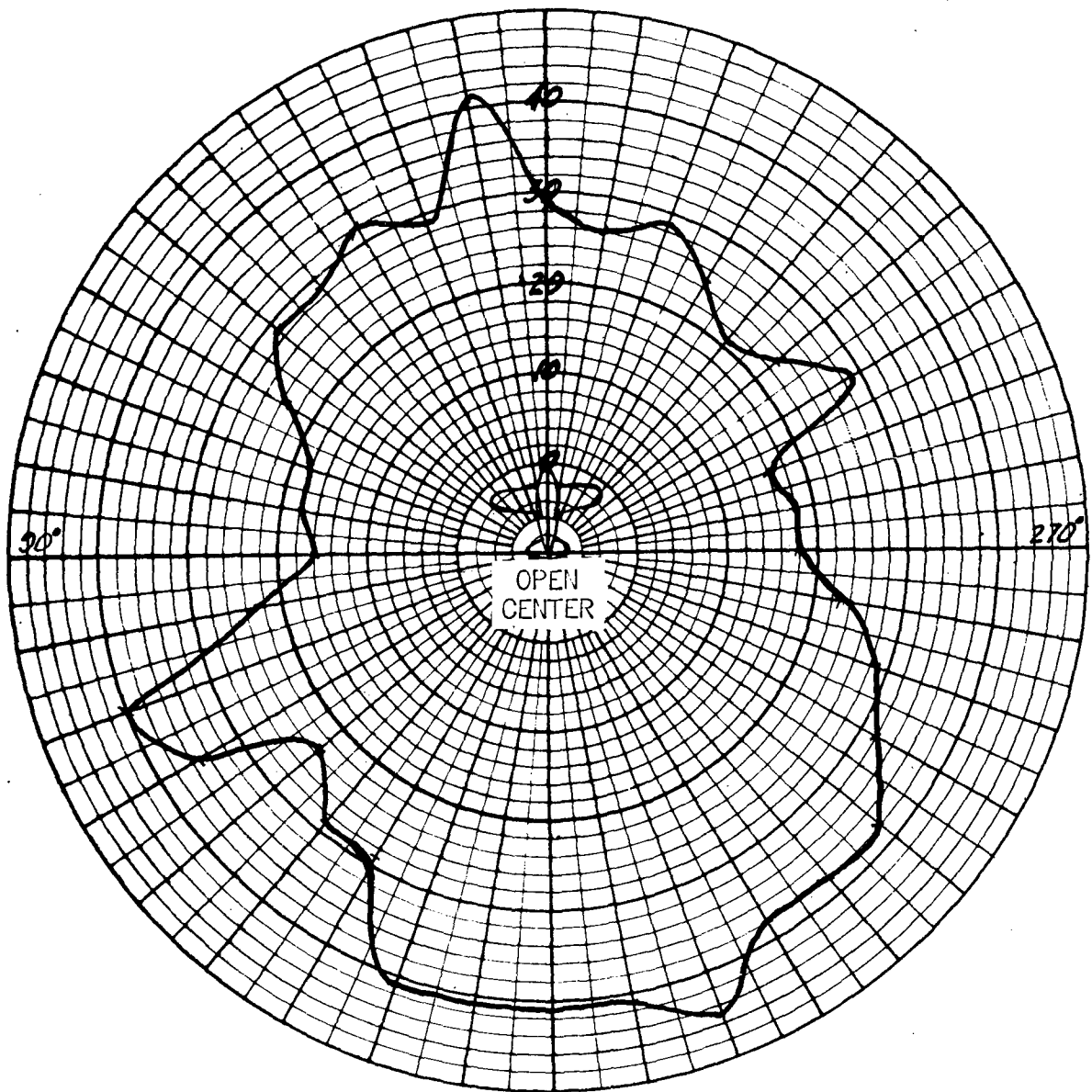


Fig. 28 36-Sided Skid Turn Pattern, 316.2 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 11,000 ft. (Pressure)
Distance - 86 nautical miles
Date - 7 March 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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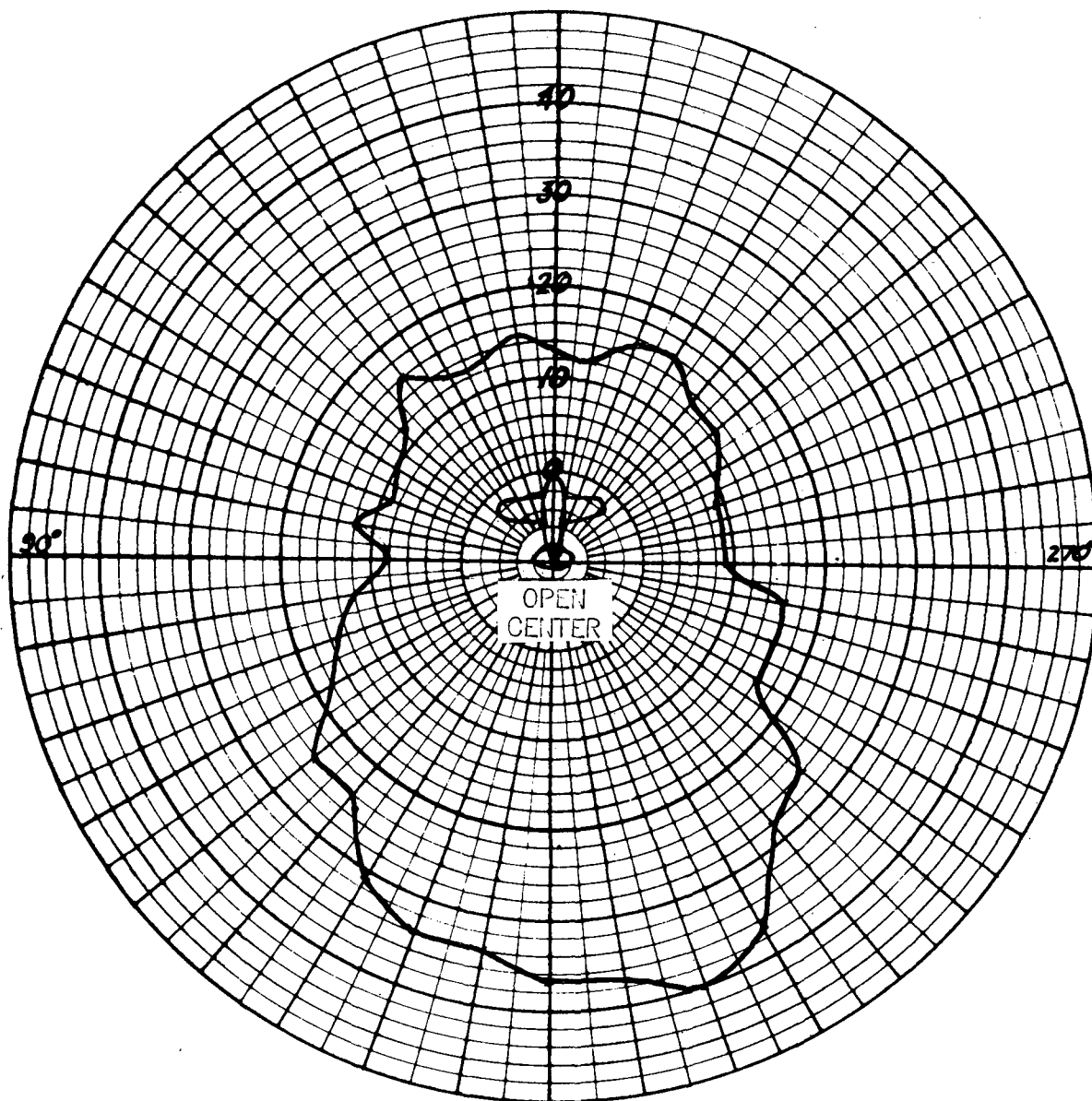


Fig. 29 36-Sided Skid Turn Pattern, 385.6 Megacycles, Elevation Angle 1.1°

Scale: 1 Division = 2 Microvolts

Antenna Type - Tail Cap
Aircraft - F-86A AF No. 48-253
Altitude - 11,000 ft. (Pressure)
Distance - 86 nautical miles
Date - 7 March 1952

Pilot - 1st Lt. W. A. Ross
Operator - W. E. Luginbuhl
Remarks - Good two-way
communication throughout
entire flight pattern

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FLIGHT TEST RECORD NO. 7

Airplane Type and No....F-86A,
AF No..48-253

Project...UHF Tail Cap Antenna
Evaluation, Maximum Range Tests

Flight No......7

E.O. No......S-102-54

Date.....28 February 1952

Time.....

Take off.....1500

Location.....Local

Landing.....1618

Max. Altitude....35,000 ft.

Total Flight....1+18

Total on Equip..1+18

Weather.....VFR

Pilot..1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To determine the maximum two-way communication range of the ultra high frequency tail cap antenna.

Test Procedure and/or Flight Program: The pilot climbed to 35,000 ft., flew a course 180° from the ground test station AF5XX, reporting positions at frequent intervals, and flew this heading until the ground station reported that the three-microvolt minimum signal strength had been received, thus determining the maximum range with a tail bearing to the ground test station. Then the pilot executed a 180° turn and flew until the ground station reported that the three-microvolt minimum had been reached, thus determining the maximum range with a nose bearing to the ground test station. This test was conducted at all three test frequencies, 229.2, 316.2, and 385.6 megacycles.

Test Data and/or Results: The maximum usable ranges of the antenna are as follows:

<u>Frequency</u>	<u>Azimuth Bearing to AF5XX</u>	<u>Max. Range in Statute Miles</u>
229.2 mc	180°	260
	All others	210
316.2 mc	180°	240
	All others	210
385.6 mc	180°	240
	All others	210

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FLIGHT TEST RECORD NO. 8

Airplane Type and No....F-86A,
AF No..48-253

Project...UHF Tail Cap Antenna
Evaluation, Air-to-Air Tests

Flight No......8

E.O. No......S-102-54

Date....4 March 1952

Time.....

Take-Off.....0930

Location....Local

Landing.....1110

Max. Altitude....35,000 ft.

Total Flight....1+40

Total on Equip..1+40

Weather.....VFR

Pilot.,1st Lt. W. A. Ross

Equipment under Test: Receiver-Transmitter RT-173/ARC-33 in conjunction with the ultra high frequency tail cap antenna as installed in an F-86A aircraft.

Purpose or Description of Flight: To determine the strength and quality of two-way communication above the F-86A at various azimuth headings and distances. This was accomplished by using an F-89C aircraft equipped with a tail cap antenna as the airborne test station.

Test Procedure and/or Flight Program: The F-89C flew a 70-mile diameter circle at 35,000 ft. over ground test station AF5XX. The F-86A flew a 15-mile diameter circle at 15,000 ft., and at a distance of 35 miles from the ground test station. The pilots of the two aircraft maintained continuous radio contact with each other and the ground test station recorded the conversation on tape. This test was conducted at the three test frequencies of 229.2, 316.2, and 385.6 megacycles.

Test Data and/or Results: The strength and quality of the two-way communication were very satisfactory at all test frequencies throughout the flight patterns.

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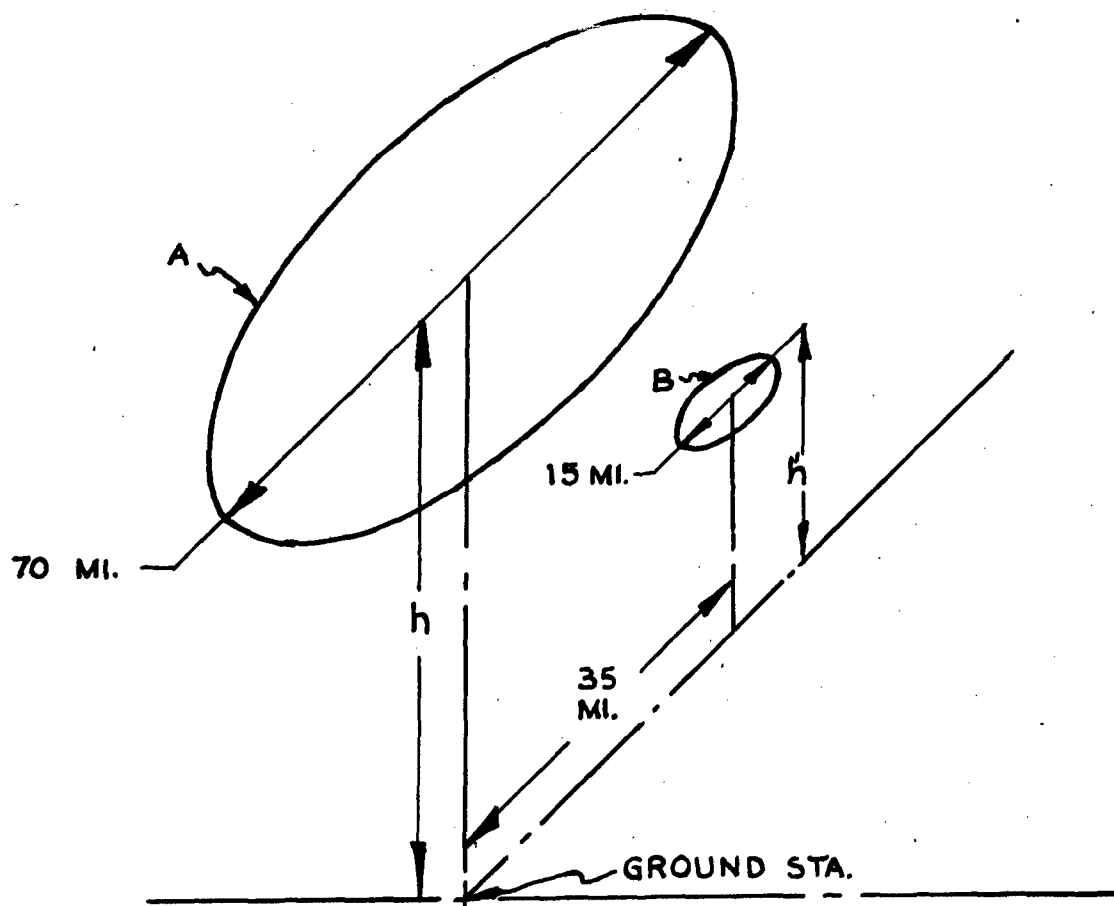


Fig. 30. Air-to-Air Test Pattern

A - Track of F-89C airborne test station

B - Track of F-86A aircraft under test

$h = 35,000$ ft. (Pressure)

$h' = 15,000$ ft. (Pressure)

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